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HEREDITY & YOUR DNA

Seven Big Misconceptions

Rossi's E-Cat: Exposing a Claimed Cold Fusion Device

Dragon Hoaxes: Piltdown Men of Creationism

Creationist Funhouse: The Red Shift

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Inquiries from the media and the public about the work of the Committee should be made to Barry Karr, Executive Director, CSI, P.O. Box 703, Amherst, NY 14226-0703. Tel.:716-636-1425. Fax: 716-636-1733. Email: bkarr@centerforinquiry.org

Manuscripts, letters, books for review, and editorial inquiries should be sent to Kendrick Frazier, Editor, Skeptical Inquirer, EMAIL: kendrickfrazier@comcast.net. Mail: 944 Deer Drive NE, Albuquerque, NM 87122. Please consult our Guide for Authors for style, reference, and submittal instructions. It is on our website at www.skepticalinquirer.org/publications/guide.

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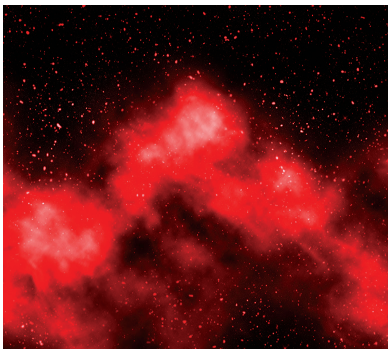

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[FROM THE EDITOR

DNA Misconceptions and Investigating E-Cat

Carl Zimmer is an award-winning science journalist whose insightful reporting on the frontiers of biology appears regularly in the *New York Times*. Of his thirteen books about science, one of my favorites is an early one, *Evolution: Triumph of an Idea,* a large-format, very enjoyable guide and companion to a PBS series on evolution. Stephen Jay Gould wrote the introduction. At our CSICon 2018 conference in Las Vegas, Zimmer gave a great talk on the powers, perversions, and potential of heredity (based on his latest book, *She Has Her Mother's Laugh*). We asked him to follow that up with an article for Skeptical Inquirer.

In this day of ubiquitous DNA test kits, Zimmer's "Seven Big Misconceptions about Heredity," our cover article, is a cautionary reminder of how easy it is to draw the wrong lessons from what we learn about our personal DNA. More than fifteen million people have already had their DNA tested, and that number may reach 100 million by 2020. The data can be useful and fun, but it's important to fight the misconceptions about it, Zimmer argues, and I agree.

I won't elaborate on them here—his article does a fine job of that. But I think even those of you who consider yourselves reasonably knowledgeable will encounter some surprises. I did. Take a look at misconceptions #2 and #6, for example.

* * *

We introduced readers to the E-Cat, a claimed but dubious cold fusion device, in our November/December 2018 issue. Florida-based inventor Andrea Rossi, who has a background that doesn't exactly inspire confidence, is now marketing the device to investors using a new weird three-hour video, released in late January. The thing is not much bigger than a small electrical space heater. (And, like a space heater, it is plugged into the wall!) Supposedly you can now arrange to have an E-Cat installed in your factory and get working heat out of it. But given Rossi's past behavior, it is doubtful that'll really happen. Rossi is, as usual, vague on engineering details and won't let independent scientists examine the device's inner workings. He has declined Australian skeptic and entrepreneur Dick Smith's one million dollar challenge.

Ian Bryce, an engineer/physicist and the chief investigator for the Australian Skeptics, has been investigating Rossi and his claims about E-Cat for years. In this issue, he presents the results of his inquiries. He also offers his own explanation of where the supposed extra energy may be coming from. Bryce finds there is no real doubt that the whole thing is fake.

We also asked energy expert and CSI Fellow Thomas R. Casten to examine Rossi's claims for us. His brief report follows Bryce's. He likewise found nothing credible. "The E-Cat presentation makes giant claims of scientific breakthroughs with no validations," Casten says. All this, he notes, is a red flag for scientific skeptics. How Rossi has been able to persuade some gullible investors that he's onto something is the real mystery.

We're going to continue our investigations. Expect more as time goes on.

—Kendrick Frazier

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The History Channel Mangles *Project Blue Book*, Mixing Fact and Fiction

Robert Sheaffer

On January 8, 2019, the much-awaited *Project Blue Book* premiered on the History television channel, which once actually showed history. It was expected to be both sensationalized and poorly acted. Those things it was. Where it exceeded expectations, however, was in the degree to which it distorted the facts of what was, in fact, a historical incident, freely mixing sensational but fictional elements with a classic UFO incident. Public discussions of this case will now be hopelessly polluted by the made-up elements that many people will now firmly believe are part of the actual story.

The first episode is titled "The Fuller Dogfight," an obvious reference to the "classic" UFO case of the Gorman dogfight of 1948. (In fact, statements made at the end of the program confirm this.) This refers to a famous case in the Blue Book files occurring near Fargo, North Dakota, in which an experienced World War II pilot reported what seemed like a dogfight with a lighted object. Serious UFOlogists generally accept that the pilot, George Gorman, though an experienced combat pilot, became disoriented while attempting to approach a lighted object at night and reported it as performing impossible feats. The object was apparently a lighted weather balloon that had been recently launched in that area. Some will argue that it is not plausible for an experienced pilot to become so disoriented and imagine or misinterpret a slowly moving object as making incredible maneuvers. They forget that J. Allen Hynek, Project Blue Book's astronomical consultant, wrote, "Surprisingly, commercial and military pilots appear to make relatively poor witnesses" (*The Hynek UFO Report*, 1977, p. 271).

This ought to bring into mind another classic UFO case, this one tragic: the death of the young pilot Frederick Valentich in Australia in 1978. His attention fixed on some unidentified

Photo: Robert Sheaffer

J. Allen Hynek (left) and Philip J. Klass

object—very likely Venus—that he believed was orbiting his position, Valentich apparently became disoriented, fell into a "graveyard spiral," and crashed into the ocean (see "The Valentich Disappearance: Another UFO Cold Case Solved," by James McGaha and Joe Nickell, Skeptical Inquirer, November/December 2013). A chilling video from the Aircraft Owners and Pilots Association, *178 Seconds to Live*, warns about the dangers of pilots becoming disoriented when flying at night or in times of poor visibility (https://bit.ly/2WctyN2). It is relevant to investigations of both the Gorman and Valentich cases (and probably to the crash killing JFK Jr. as well).

Here is a short list of falsehoods shown or implied in "The Fuller Dogfight" episode:

- Gorman shot at the object.
- Gorman was sent to the infirmary for an extended period of time with psychological problems.
- Gorman collided with the object, which damaged his plane.
- The UFO took control of Gorman's plane.
- Gorman somehow anomalously heard a radio station during the incident and became obsessed with the song it was playing.
- Hynek traveled to Fargo to investigate this case on site. False. Indeed, Mark O'Connell, author of the first biography of J. Allen Hynek, *The Close Encounters Man*, noted on Facebook that in the episode "Hynek drove from Fargo, North Dakota to Columbus, Ohio seemingly in a matter of minutes. It's a 15 hour drive today, but back then there were no interstates."
- Hynek and his Air Force handler, a pilot, went up in a plane to try to duplicate the encounter. The plane crashed, but both survived. This is beyond ridiculous.
- A Man in Black was watching the investigation, uselessly, from a distance. In fact, the stories about the Men in Black originated with Albert K. Bender in 1953.

The second episode involves a UFO sighting and the so-called Flatwoods Monster in West Virginia. Here is a bloopers list for that episode:

- Dr. Hynek did not travel to West Virginia to investigate this incident. In fact, Project Blue Book did not perform its own investigation of the Flatwoods case; they only collected a few press clippings.
- Witnesses' eyes were not burned, and there were no physical symptoms in anyone.

- Debris from an alleged spacecraft were not found in the woods. Nothing was found, and no object was removed.
- The ground was not radioactive.
- The whole town did not show up and threaten to lynch—or at least to tar-and-feather—the principal UFO witness.
- There was no witness in a psychiatric hospital, and no people killed themselves over this.
- The woman who has befriended Mimi Hynek turns out to be a Russian spy. Apparently, the Soviets sent Boris and Natasha to spy on Hynek and Project Blue Book.
- When the boy is supposedly looking at Mars in a small telescope, they set up the telescope backward. It is pointing at the ground, not the sky, but nobody seems to notice this.

For a credible account of the Flatwoods Monster incident, see the results of CSI's own investigator Joe Nickell in the December 2000 Skeptical Inquirer (https://bit.ly/2R4gKo8). The reported UFO was obviously a fireball meteor. Nickell notes that "the fireball had been seen on a relatively horizontal trajectory in various states." So, like the supposed Kecksburg UFO crash in 1965, the Flatwoods "UFO" was not just a local sighting but actually a distant object high above the earth, seen across a very wide area. As for the "monster," Nickell agrees that it was probably a large owl sitting on a tree branch, and he sketched an illustration suggesting what the witnesses actually saw.

The third episode was based on the Lubbock Lights in Lubbock, Texas, in August 1951. UFO researcher Curt Collins suggests that the famous UFO case "may have been misidentified *and* hoaxed":

> There weren't any radar reports, car stoppages or power outages, as depicted in this week's episode, but there were photographs—photographs that may not be as good as first thought, if recent investigation is any indication. … The "real" Lubbock Lights reported by the eyewitnesses were loose formations of dim lights. It was an illusion of sorts, not distant large objects flying at great speed, just flocks of migrating birds that reflected city lights as they passed over Lubbock at a much lower altitude. (https://bit.ly/2WvxwRp)

As for the purported photos of the Lubbock Lights, photo analyst Nab Lator, the first to decipher the plaque in the so-called Roswell Slides (see "The 'Roswell Slides' Fiasco: UFOlogy's Biggest Black Eye," SI, September/October 2015), notes:

> The lights on photographs A and B superimpose perfectly! Isn't that amazing? … [Photographer] Hart said he only had time to take "two photographs of the second flight, and when the lights came back a third time, he took three more." … The perfectly matching pattern between photos A and B is incredible because there should be at least some deformation due to the change in perspective if the formation was moving at all as described between the two successive photos. … He could have done it very simply, punched holes in a cardboard with a pencil and taken pictures of it against the light, looking just as dark as the night sky. Only he should have changed the cardboard between photo A and B to make the series more believable.

Particularly absurd in this episode was the depiction of federal secret agents kidnapping Major Donald E. Keyhoe, the head of the major UFO group NICAP, and holding him at gunpoint. This is patently absurd, and yet there are people on social media asking if it actually happened.

As of this writing, four episodes of *Project Blue Book* have been broadcast. The fourth episode involves Project Paperclip, a program under which German rocket scientists were brought into the United States following World War II to continue to work on missiles. Hynek and his Blue Book boss Captain Quinn are supposedly sent to Alabama to investigate UFO sightings (they were not). They break into a nearby military base and get arrested but then discover a connection between the UFO sightings and a secret space program being run by Wernher von Braun, who keeps what looks like an alien alive in a vat of liquid. The Blue Book captain starts a bar fight and gets into trouble once again. They discover that Von Braun has built a reconstruction of a flying saucer that the Nazis had supposedly invented and that he has been forcing unwilling servicemen to serve as guinea pigs riding in it. One is trundled inside a saucer, which then rises into the air and disappears into another dimension or someplace. Again, this is beyond crazy and simply adds to the torrent of public misinformation on UFO matters.

As a point of historical interest, Dr. J. Allen Hynek was an invited speaker at CSICOP's 1984 conference at Stanford, California. He was a member of the UFO Panel, which I moderated and whose other members included Philip J. Klass, Andrew Fraknoi, and Roger Culver. Hynek, who was invited to provide a different perspective from the others, spoke way too long, going over his allotted time, and I struggled to keep the panel close to its published schedule!

If television producers want to create a fictional UFO series, that is fine. But this program references real people by their real names, a real government program, and real incidents. It then mixes in absurd and invented details, while claiming that the show is based on real events. They have done a great disservice to their viewers and to anyone else who cares about understanding the facts behind reported UFO incidents.

This program references real people by their real names, a real government program, and real incidents. It then mixes in absurd and invented details, while claiming that the show is based on real events. They have done a great disservice …

Robert Sheaffer is a longtime skeptical UFO writer and researcher. He is the author of *Bad UFOs*, *Psychic Vibrations*, and *UFO Sightings*. His blog is at www.BadUFOs.com.

Canadian Psychic Charged with 'Witchcraft,' Media Get the Message Wrong

Benjamin Radford

In October 2018, Dorie Stevenson of Milton, Ontario, who goes by the name Madeena, was arrested by police and formally charged with witchcraft. Stevenson was not arrested for practicing magic *per se*; charges were laid under Section 365 of Canada's Criminal Code, "Witchcraft—Fortune Telling," as a form of fraud: "Every one who pretends to practise or to use any kind of witchcraft, sorcery, enchantment or conjuration; undertakes, for a consideration, to tell fortunes; or pretends from his skill in or knowledge of an occult or crafty science to discover where or in what manner anything that is supposed to have been stolen or lost may be found." Other charges included fraud and extortion.

The archaic nature of the phrasing of such statutes spurred spurious and ill-informed news headlines and articles, such as in *The Washington Post* ("In Canada, Pretending to Be a Witch Is a Punishable Offense") and BBC News ("Canada's Last Witch Trials: Women Accused of Fake Witchcraft"). The articles misleadingly framed the issue as about freedom of religious beliefs and persecution of pagan witches, not using psychic powers as a pretense for theft. The BBC piece, which reported that "The charges could lead to Canada's last witch trials, as the section of the law banning pretending to practise witchcraft will soon be repealed," is especially egregious and historically ignorant; in the real witch trials victims were accused of real—not fake—witchcraft. The phrasing also raised flags among some lawmakers in 2017 who referred to them as "obsolete," though others noted that despite their dated terminology they do help protect Canadian citizens. The code was repealed by the Canadian Parliament on December 13, 2018, under Bill C-51.

The arrest was the culmination of a five-month investigation involving several victims, some of whom claimed they had been bilked out of tens of thousands of dollars. Stevenson's website states without irony that "As an experienced and gifted Milton psychic reader I am aware that you could have had false hopes and promises made to you that has led you into a deeper path of confusion. ... As a trusted psychic reader I provide guidance and suggest solutions in the following matters," and one of her areas of expertise is "court cases."

The archaic nature of the phrasing of such statutes spurred spurious and ill-informed news headlines and articles.

In related alleged psychic fraud news, a New York woman who claims to be psychic has filed a lawsuit against psychic-busting skeptic and private investigator Bob Nygaard. Janet Lee—who has a history of arrests for fraud—seeks millions in damages, saying that Nygaard has harassed her and cost her business by contacting her clients and telling them they've been scammed and encouraging them to contact police and seek refunds. Her lawsuit, filed in the Supreme Court of Westchester County, states:

> Janet Lee is a practicing psychic, and for those individuals who believe in psychics and seek out their services, she renders the services that they expect of her. To label her a fraud and a "scammer" absent proof that she cannot render the services that she and her clients believe she has the ability to render, is slanderous and defamatory and has damaged her ability to practice her profession and make a living.

Benjamin Radford is the deputy editor of the Skeptical Inquirer.

The Rise and Fall of the 'Momo Challenge' Online Suicide Game Conspiracy

Benjamin Radford

In February 2019, kids and their parents around the world were introduced to a new deadly online danger: a mysterious and terrifying online figure known as "Momo," whose creepy image is that of a bug-eyed woman in the Japanese horror tradition (it's actually a co-opted, unrelated sculpture titled "Mother Bird," created in 2016 by artist Keisuke Aisawa).

The targeted teens are supposedly sent violent or gruesome images by Momo through an app or social media and encouraged to reply. They are threatened if they don't and forced to agree to conduct a series of violent and bizarre tasks—resulting in death. It's called the "Momo Challenge."

The Rise of Momo

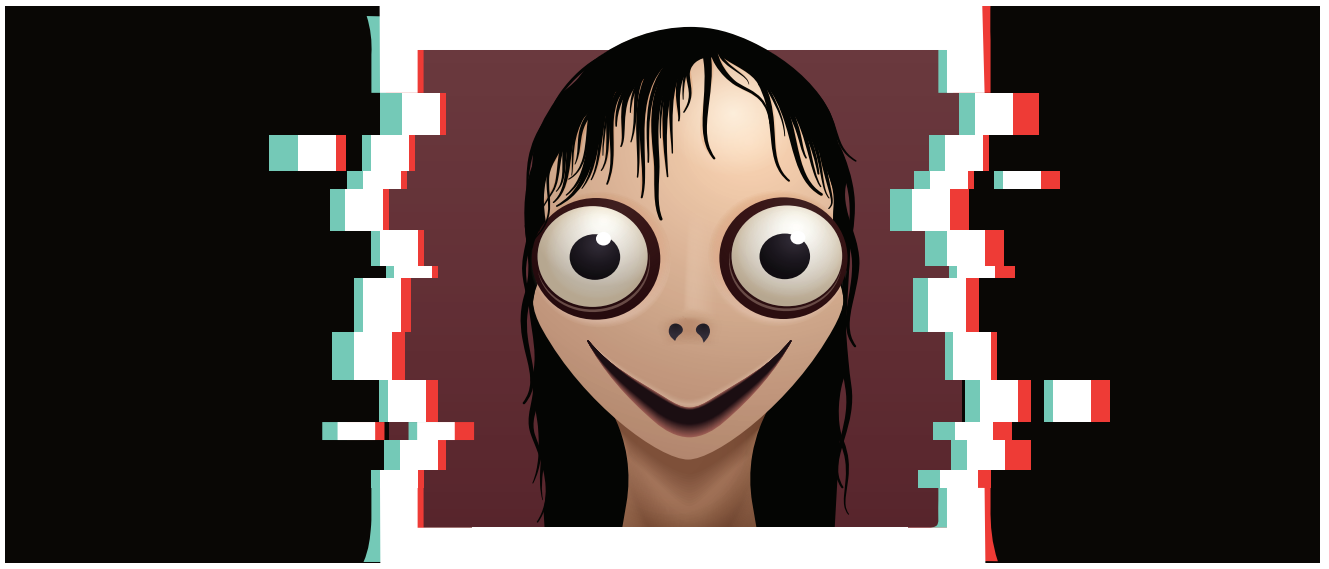
The story seems to have begun in mid-2018 with the death of an Argentine teenager said to have been driven to suicide because of social media threats. The story circulated in chatrooms but lay mostly dormant until early 2019, when British tabloids picked up the story and gave it attention (if not legitimacy). It escalated further when a British mother warned other parents on social media that her young son had scared his friends with frightening stories of Momo. One news article breathlessly reported on the Momo-mortified mom:

> It was revealed on Thursday, February 21 that a seven-year-old boy from Manchester was a victim of the game. His mum was deeply concerned to find out he had made several of his peers cry by telling them Momo was going to come into their room at night and kill them. She is urging parents to be aware of the shocking whatsapp challenge—and its dangers.

Urban, or contemporary, legends are marked by plausibility; they are told as true and often are said to have really happened … to a friend of a friend, of course.

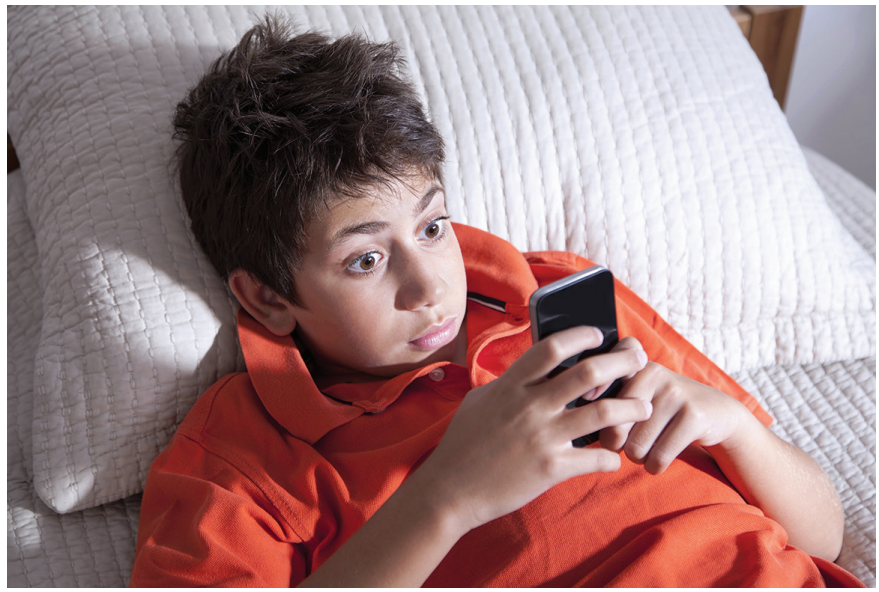
The Momo Challenge is a repackaged version of an older, nearly identical and debunked suicide game panic called the "Blue Whale Game," which circulated widely in 2017. Urban, or contemporary, legends are marked by plausibility; they are told as true and often are said to have really happened … to a friend of a friend, of course. Part of the reason these stories have credibility for many parents and school officials is that there is a grain of truth to them—though not to the rumors of online suicide games specifically. Cyberbullying and sexting extortion are genuine online dangers that teens face; there are thousands of documented cases where both teens and adults have been forced to do things for strangers, including sending both money and nude photos. For concerned parents, it's not much of a logical leap to online suicide games targeting teens and run by a cabal of conspirators.

I previously researched the first two deaths claimed to have been associated with the Blue Whale Game, that of a female teen in Atlanta, Georgia, in May 2017 and a male teen in San Antonio, Texas, two months later. In both cases, there was no real evidence of any social media suicide game. As for the death of the Argentine teen driven to suicide by



Momo mentioned above, police have not confirmed any link to her death, much less the existence of the Momo Challenge. Moral panics such as these are part of a very old tradition. These scary media stories are very popular in part because they are fueled by parents' fears and wanting to know what their kids are up to. Indeed, the Blue Whale Game and the Momo Challenge have all the hallmarks of a classic moral panic.

The Blue Whale Game and the Momo Challenge have all the hallmarks of a classic moral panic.



The Fall of Momo

The rise of the Momo Challenge, or something like it, was both predictable and expected. Perhaps even more interesting from folkloric and skeptical perspectives is the (apparently) short shelf life the challenge had. The internet age has spawned a world in which rumors and legend can and do get shared around the world in a matter of minutes. Examples of digital-age Boogeymen include the chupacabra, Slenderman, and Momo.

Inevitably, the sensationalist and alarming rumors are widely shared, while the more sober, skeptical analyses lag far behind and are comparatively little seen or noticed. The Momo Challenge seems to be a rare exception, due in large part to widespread news media coverage, much of it at least nominally skeptical and quoting folklorists and skeptics. I was quoted in a February 26 online article for *Rolling Stone* and followed up the next day with an in-depth Special Article for the CSI website. But the story gathered steam, and by the first week of March, articles on the Momo challenge appeared on dozens of prominent websites.

There was of course a plethora of panicky parents quoted in blogs and news articles, including those shared by regional news stations angling for a local angle and tabloids with lurid photos. But overall the reaction was heartening. One CNN story, for example, offered the skeptic-delighting headline, "Parents, Please Stop Freaking Out Over the Momo Challenge," and *The Atlantic*'s headline was simply and refreshingly "The Momo Challenge Is Not Real" (where I was also quoted). YouTube took to Twitter on February 27 to state that "We want to clear something up regarding the Momo Challenge: We've seen no recent evidence of videos promoting the Momo Challenge on YouTube. Videos encouraging harmful and dangerous challenges are against our policies." Debunking site Snopes asked, "How Much of a Threat is the Purported 'Momo Challenge' Suicide Game?" and answered skeptically. Much credit goes to Susan Gerbic and her Guerilla Skepticism on Wikipedia Team, which helped provide accurate, fear-calming information and resources on the Wikipedia page for journalists and the public alike.

Not only was this Boogeywoman defanged within about a week, but she was soon widely mocked on social media: Memes soon circulated hundreds of Momo in silly situations. Momo was suddenly meeting the Queen of England, breaking down the Berlin Wall, landing on the moon, and making "Yo Mama" (or is that "Yo Momo"?) jokes. Momo went from the mascot for online teen suicide conspiracy to a punchline within a week.

One CNN story offered the skeptic-delighting headline, "Parents, Please Stop Freaking Out Over the Momo Challenge."

Especially when dealing with extraordinary claims of conspiracies and online death cults, it's easy for grief and moral panic to override critical thinking. The evidence for the Blue Whale game and the Momo Challenge is built largely on rumor and conjecture instead of solid evidence. This is only the latest in a long series of similar moral panics and outrages shared on social media and aided by sensationalist news media. Often the best antidote to these rumors is a healthy dose of critical thinking, media literacy, and skepticism.

Engagement with Fake News Extremely Concentrated, New Study Finds

Kendrick Frazier

Ever since the 2016 presidential election, fake news has become an increasing concern because of how fast it spreads and how corrosive it can be to democratic institutions that depend on a properly informed citizenry.

Social scientists and others have been trying to study and better understand the phenomenon. Last year, scientists from MIT published a study in *Science* of how stories were disseminated on Twitter from 2006 to 2017 and found that false stories spread much faster and to far more people than true ones ("Lies and False News Spread Faster …" Skeptical Inquirer, July/August 2018).

Now six researchers at Northeastern University, Harvard, and the University at Buffalo have published a study of fake news on Twitter during the U.S. presidential election (Grinberg et al., "Fake News on Twitter During the 2016 U.S. Presidential Election," *Science* 363: 374–378, January 25, 2019). They found that engagement with fake news sources is extremely concentrated. Only 1 percent of individuals accounted for 80 percent of exposures to fake news sources. And 0.1 percent accounted for nearly 80 percent of fake news sources shared.

They followed a definition of fake news outlets published earlier by one of the authors, David Lazar, who conceived the new study: *fake news outlets* are those that have the trappings of legitimately produced news but "lack the news media's editorial norms and processes for ensuring the accuracy and credibility of the information."

One class of fake news sources ("black") were a set of websites taken from preexisting lists of fake news sources prepared by fact checkers, journalists, and academics. These sites published almost exclusively fabricated stories. A second class of sites (dubbed "red") spread falsehoods that clearly reflected a flawed editorial process. A third class ("orange") represented cases where checkers were less certain that the falsehoods stemmed from a systematically flawed process.

The goal was to study how ordinary citizens experience misinformation on social media platforms. The researchers collected tweets sent by 16,442 accounts that were active during the 2016 presidential election. They obtained lists of their followers and followees (accounts they followed). They determined that their panel was largely reflective of voters in age, gender, race, and political affiliation.

When totaled across all panel members, 5 percent of aggregate exposures to URLs were from fake news sources. That fraction varied by day, and it increased in all categories during the final weeks of the campaign. As for sharing of content, 6.7 percent of political URLs shared by the accounts came from fake news sources.

But those numbers obscure the major finding. What the study found was that content from fake news sources was highly concentrated, both among a small number of websites and a small number of panel members. Within each of the three categories of fake news, 5 percent of sources accounted for more than 50 percent of exposures. The top seven fake news sources—all in the red and orange categories—accounted for more than 50 percent of fake news exposures.

Scientists have found that engagement with fake news sources is extremely concentrated. Only 1 percent of individuals accounted for 80 percent of exposures to fake news sources. And 0.1 percent accounted for nearly 80 percent of fake news sources shared.

Content was also highly concentrated among a small fraction of panel members. A mere 0.1 percent of the panel members consumed 80 percent of the volume from fake news sources.

The authors say these "supersharers" and "superconsumers" of fake news—

those accountable for more than 80 percent of fake news sharing or exposure—dwarfed typical users in their affinity for fake news sources, and in their activity.

As for political affinities, the study found that fewer than 5 percent of people on the left or center ever shared any fake news content, yet 11 percent of people on the right and 21 percent of people on the extreme right did.

All in all, the vast majority of fake news and shares were attributable to tiny fractions of the population.

So the good news is that the overwhelming majority of users did not share fake news. And "for the average panel member only 1.18 percent of political exposures consisted of content from fake news sources." This seems to fit with most previous studies, the authors say.

"As in these studies, we found that the vast majority of political exposures, across all political groups, still came from popular nonfake news sources. This is reassuring in contrast to claims of political echo chambers and fake news garnering more engagement than real news during the election."

And they say the findings suggest that fake news could be reduced by having social media platforms "discourage users from following or sharing content from the handful of established fake news sources that are most pervasive. They could also adopt policies that disincentivize frequent posting, which would be effective against flooding techniques while affecting only a small number of accounts." The researchers also called on Twitter and other social media platforms to engage more closely with fact-checking organizations. All this could contribute to "more resiliency to misinformation campaigns during key moments of the democratic process."

Kendrick Frazier is the editor of the Skeptical Inquirer.

Michael Mann Wins $200,000 Tyler Prize for His Courageous Advocacy of Climate Science

Kendrick Frazier

Michael E. Mann (right) with fellow 2019 Tyler Prize winner Warren M. Washington.

Climate scientist and CSI Fellow Michael E. Mann is one of two winners of the prestigious 2019 Tyler Prize for Environmental Achievement.

Mann is Distinguished Professor of Atmospheric Science and director of the Earth System Science Center at Penn State University. He is known for his courageous championing of the findings of climate science in the face of aggressive opposition from nonscientist forces.

He shares the Tyler Prize with Warren M. Washington, Distinguished Scholar at the National Center for Atmospheric Research in Boulder, Colorado. Washington is one of the fathers of numerical modeling of the complex interactions within and between Earth's land, ocean, and atmosphere. Washington literally wrote the earliest book about climate modeling.

The Tyler Prize has been called the "Nobel Prize for the Environment." The $200,000 prize will be shared equally by the two scientists.

"The Tyler Prize Executive Committee is honored to recognize two outstanding scientists, who have not only advanced our knowledge of climate change, but also demonstrated exceptional courage and commitment to public policy," said Julia Marton-Lefèvre, Tyler Prize chair.

Mann is known for his courageous championing of the findings of climate science in the face of aggressive opposition from nonscientist forces.

Mann pioneered the use of proxy data to estimate global temperatures back to more than a thousand years into the past. These proxies include ice cores, tree rings, and lake sediments. His analysis showed that our planet's climate was getting warmer, and rapidly so. This produced a pat-

tern that in 1999 became known as the "Hockey Stick Graph." Some have labeled it "the most controversial chart in science."

Oil and gas lobbyists began attacking the Hockey Stick in an attempt to discredit Mann, its junior author. As the Tyler committee points out, "Dr. Mann endured blistering legal and political attacks, including the carefully orchestrated email hack that became known as 'Climategate.'" (SI's coverage included "Climate Wars: Science and Its Disputers," March/April 2010; D. Morrison, "Disinformation about Global Warming," March/April 2010; M. Boslough, "Mann Bites Dog: Why 'Climategate' Was Newsworthy," May/June 2010; "The Winter of our Discontent," May/June 2010; "Climate Wars: Reaction to SI Coverage," July/August 2010; and M. Boslough, interview, "Michael Mann and the Climate Wars," November/December 2016.)

The Tyler awards committee points out that despite this intense scrutiny, Mann chose not to retreat to his lab but to accelerate his efforts to make the science demonstrating climate change accessible to the public.

"He has become one of the 'go-to' scientists when the U.S. media wants an explanation for the latest scientific findings about climate change, or the connection between the latest disaster and climate change," said Professor Jane Lubchenco, former administrator of the National Oceanic and Atmospheric Administration (NOAA). "He is a staunch defender of good science, but he does not suffer fools lightly, and routinely calls them out in a very public manner. He is edgy, but right."

Despite intense scrutiny, Mann chose not to retreat to his lab but to accelerate his efforts to make the science demonstrating climate change accessible to the public.

"Professor Mann did not choose the easy way out," said Naomi Oreskes, Harvard professor of the history of science and author of the book *Merchants of Doubt*. "For his courage in the face of this challenge, Mike Mann is not just a great scientist, but also a hero."

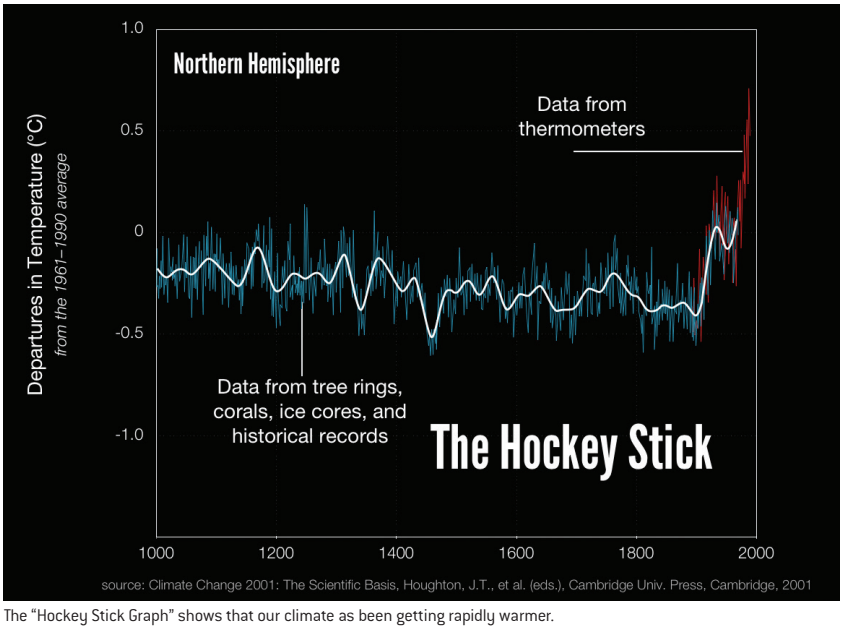
In physicist and CSI Fellow Mark Boslough's interview with Mann in the November/December 2016 Skeptical Inquirer, he noted that the attacks on Mann "backfired spectacularly in your case." Mann replied, "Well, yes—I like to think the hyenas tangled with the wrong zebra."

But he pointed out that the same tactics continue to be deployed, with politicians serving subpoenas on climate scientists and otherwise attempting to send "a collective chill throughout the entire climate science community." He added, "The motive is personal destruction." He concluded, "The silver lining is that we are now creating a whole generation of scientist communicators who are not only doing great science but are effectively communicating the science and its implications to the general public."

Mann was a speaker at both CSICon 2016 and 2017, and in early 2018 the Committee for Skeptical Inquiry (CSI) announced his election as a fellow. The citation called him "a noted climate scientist" who advanced "the scientific understanding of historic climate change" and is also "active in public outreach and countering misunderstandings about the findings of climate research" (March/April 2018).

"I'm truly honored to be recognized by the Tyler Prize committee and pleased they mentioned my science outreach efforts in their praise," Mann told the Skeptical Inquirer. "Of course, public outreach and communication is a community-wide effort, and I thank my friends at CSI for the role they've played in fighting pseudoscience and antiscience as we seek to inform the public and policymakers about matters of policy-relevant science."

Mann and Washington will deliver a public lecture on their work on May 2 at the UCSF Mission Bay Conference Center. In a private ceremony on May 3, the Tyler Prize Executive Committee and the international environmental community will honor the two laureates during a ceremony at the Ritz Carlton Hotel, San Francisco.



The "Hockey Stick Graph" shows that our climate as been getting rapidly warmer.

Kendrick Frazier is editor of the Skeptical Inquirer.

Hall, Hermes, Loftus, Frazier Named GWUP Fellows

Harriet Hall, Britt Marie Hermes, Elizabeth Loftus, and Kendrick Frazier have been elected fellows of GWUP, the German skeptics group. Also named were Mark Lynas, a British author, journalist, and environmentalist who focuses on climate change, and Bernhard Hoecker, a skeptical comedian. The announcement was published in GWUP's magazine *Skeptiker* (4/2018).

"The GWUP is pleased to welcome further outstanding personalities of research, teaching and science communication as members of their Fellow Board," the article said. "With their achievements in science and critical thinking, they have made a decisive contribution to the enlightened worldview."

GWUP previously announced several other fellows, including Susan Blackmore, Mario Bunge, Edzard Ernst, Krista Federspiel, James Randi, and Simon Singh.

Harriet Hall

Britt Marie Hermes

Elizabeth Loftus

Kendrick Frazier

Skeptics' Sting Delivers High-Profile Hit to Psychic Credibility

Benjamin Radford

The credibility of psychics took a huge hit in February and March of 2019 thanks to skeptical activists. Veteran skeptics Susan Gerbic and Mark Edward went undercover, posing as a couple, to see a psychic named Thomas John. They were given the outlines of a fictional backstory—some details of which they themselves didn't know but had been posted by others posing as them on fake social media profiles in a clever double-blind experiment. Around the same time, Kenny Biddle and others conducted another undercover investigation into a different psychic named Matt Fraser, who was appearing at a resort in Pennsylvania. Taken together, they offer an in-depth look at both hot and cold reading and other techniques that modern performers use to fool the public.

The credibility of psychics took a huge hit in February and March of 2019 thanks to skeptical activists.

The details of these investigations can be found on the Committee for Skeptical Inquiry website. See Susan Gerbic's February 21 online article "Operation Pizza Roll: Thomas John" at http://tinyurl.com/y3hy3vjn and Kenny Biddle's February 25 article "Undercover at a Psychic Group Reading" at http://tinyurl.com/y3qs6w4e.

Skeptical investigations of psychic claims are nothing new, of course, and have filled the pages of this magazine for decades. However, these were among the highest-profile successes in years, perhaps going back to James Randi's exposure on *The Tonight Show*. These operations got widespread publicity with the publication of an article in *The New York Times Magazine* on March 3 by Jack Hitt titled "Inside the Secret Sting Operations to Expose Celebrity Psychics" (and even more when the story was posted online and then was adapted and republished in the April 5 *The Week* magazine). As skeptics, it's easy to focus on the negative, on the seeming cornucopia of woo and deception in the world, but now and then skepticism gets some well-deserved success and limelight.

Remembering Martin Gardner

Bryan Farha

On February 28, 2019, the University of Oklahoma held a free public event, "Martin Gardner's Legacy: One Oklahoman's Imprint on Math, Magic, and Philosophy." It was well attended by mathematicians, magicians, educators, students, philosophers, and scientists. Gardner's extraordinary life and career as a prolific science and math writer was highlighted by his *Scientific American* column, "Mathematical Games," which ran for a quarter of a century.

Gardner's extraordinary life and career as a prolific science and math writer was highlighted by his *Scientific American* column.

The event began with remarks from his son, Jim Gardner, esteemed in his own right as an Emeritus Professor of Educational Psychology at the University of Oklahoma and for his research in the use of technology in educational settings. Next on the agenda was "reflections" of Martin Gardner from a few speakers familiar with his work. These topics included "Mathemagic with a Deck of Cards" by Colm Mulcahy (professor of mathematics at Spelman College); "Gardner, Play and Disciplinary Boundaries" by Robert Crease (Philosophy Department Chair at Stony Brook University); and "The Gathering for Gardner Foundation" by Nancy Blachman (Foundation Chair).

Then it was time for the main event. The keynote address was titled "Having Fun with Math and Computers," presented by MIT computer science professor and MacArthur Fellow Erik Demaine. This riveting address was both educational and entertaining as the topics he presented were all Gardner-inspired: geometric folding algorithms, origami, polyhedra, unique mathematical fonts and typefaces, and puzzles of all kinds, including the Instant Insanity puzzle created in 1967. Demaine didn't just discuss them—he demonstrated them himself or with the use of computer graphics and videos. To give a sense of how moving this presentation was, he showed some puzzles that even computers could not solve. This was a presentation that Skeptical Inquirer readers would have thoroughly enjoyed.

It's with special thanks to Jim Gardner and the University of Oklahoma for keeping alive the legacy of this very special science and mathematics writer, skeptic, magician, and philosopher. His work still inspires both children and adults all over the world.

Acknowledgment

Special thanks to Cole Harroz, who served as a consultant on this piece.

Bryan Farha is a professor, CSI consultant, and editor of *Pseudoscience and Deception: The Smoke and Mirrors of Paranormal Claims*.

HAVING FUN WITH MATH AND COMPUTERS
Keynote Speaker
ERIK DEMAINE,
Professor of Computer Science, MIT, MacArthur Fellow
Additional reflections:
MATHEMAGIC WITH A DECK OF CARDS
Colm Mulcahy,
Professor of Mathematics, Spelman College
GARDNER, PLAY, AND DISCIPLINARY BOUNDARIES
Robert Crease,
Department Chair, Professor of Philosophy, Stony Brook University
THE GATHERING FOR GARDNER FOUNDATION
Nancy Blachman, Chair
MARTIN GARDNER'S LEGACY:
One Oklahoman's Imprint on Math, Magic, and Philosophy
Thursday, Feb. 28
Great Hall, Sam Noble Museum
A free public event on the legacy of world-famous Oklahoman Martin Gardner will take place on Thursday night, Feb. 28, in the Great Hall of the Sam Noble Oklahoma Museum of Natural History. Countless mathematicians, magicians, scientists and philosophers have been inspired by Oklahoman Martin Gardner, especially by his 25-year run as the author of the Mathematical Games column in Scientific American. His books on puzzles, tricks and magic continue to delight young and old the world over.
6:30 PM Reception | 7:00 PM Lecture
Sponsored by the Office of the Senior Vice President and Provost, OU Honors College, OU Math Department and OU Department of Philosophy.
For information or accommodations, contact the Honors College at honors@ou.edu or call (405) 325-9088. The University of Oklahoma is an equal opportunity institution www.ou.edu/eeo.

Erik Demaine delivering his keynote address, "Having Fun with Math and Computers."

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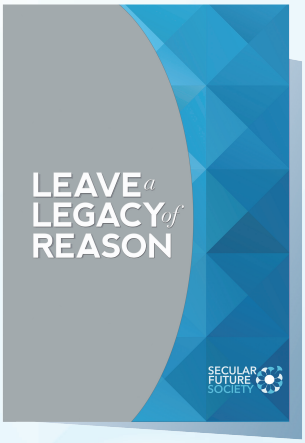

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Skepticism and the Persuasive Power of Conversion Stories

Scott O. Lilienfeld

Those of us in the skeptical community have our work cut out for us. In the process of disseminating scientific thinking, we often challenge unsubstantiated beliefs that are held with considerable conviction. Every one of us who has tried to persuade committed believers in astrology or homeopathy that they are mistaken knows just how challenging—and in some cases, how futile—this endeavor can be. We skeptics rarely win popularity contests.

So how can we effectively persuade believers in dubious claims to change their minds, or at least to give our contrary ideas a fair hearing? Traditionally, much of the science communication literature has operated implicitly from the "information deficit model." From this perspective, which is premised on Sir Francis Bacon's principle that knowledge is power, the primary driver of pseudoscience is inadequate scientific literacy. If we could only find a means of better educating the general public about science, this model assumes, most unsupported ideas would lose their stranglehold over the populace. Nevertheless, recent data suggest that the information deficit model, although probably containing a kernel of truth, does not tell the full story. For example, research by Dan Kahan of Yale University and his colleagues reveals that among political conservatives (but not liberals), higher levels of scientific literacy are associated with *greater* skepticism of global warming and its damaging impacts (Kahan et al. 2012). Although such findings are open to multiple interpretations, they raise the possibility that imparting scientific knowledge might in some cases backfire, perhaps by affording individuals who hold unwarranted beliefs the intellectual ammunition to rebut scientific arguments. If corrective science education has its limits, are there better alternatives to debunking erroneous beliefs?

Every skeptic who has tried to persuade committed believers in astrology or homeopathy that they are mistaken knows just how challenging—and in some cases, how futile—this endeavor can be.

A recent study conducted by Benjamin Lyons and colleagues, published in the peer-reviewed journal *Public Understanding of Science* (Lyons et al. 2019), offers a potential answer. The authors aimed to determine whether presenting participants with "conversion stories"—descriptions of individuals who once held an unsubstantiated belief but who later changed their minds—might be an effective, albeit underutilized, persuasion technique.

To test this hypothesis, they showed participants video clips from a 2013 conference talk by Mark Lynas, a British author and environmental activist who was initially a staunch opponent of genetically modified organisms (GMOs) but later became persuaded that GMOs were safe. Participants, who were 727 American adults recruited for an online survey, were randomly assigned to view three different clips of Lynas: (1) one in which he simply advocated for GMOs, (2) one in which he advocated for GMOs and noted that he had initially been opposed to GMOs, and (3) one in which he advocated for GMOs and explained what had prompted him to change his mind. Both conversion conditions (2 and 3) led to more positive attitudes toward GMOs than did condition 1, with no significant differences between conditions 2 and 3.

It is not known how conversion experiences work as persuasive tactics. Lyons and colleagues found that their two conversion conditions appeared to

operate by boosting the strength of the speaker's arguments rather than by enhancing his personal credibility. Other data suggest that an effective means of refuting scientific misconceptions is to supplant false beliefs with an equally or more compelling explanatory narrative (Lewandowsky et al. 2012). For example, if we want to rebut the erroneous belief that vaccines cause autism (now called autism spectrum disorder), presenting individuals with compelling data that autism risk is substantially inherited may help, as may presenting them with narratives describing how and why even intelligent people can fall prey to the erroneous belief.

It would be useful for the skeptical community to gather conversion stories and determine whether they can be harnessed in the service of beneficial attitude change.

The use of conversion stories for persuasive purposes is hardly new. Social psychologists who have studied persuasion have long underscored the utility of inoculating people against false claims by first presenting them with information that seemingly supports these claims and then refuting it (Pratkanis 2007). Moreover, legal scholar Cass Sunstein and his colleagues have written of the persuasive power of "surprising validators": people we would not typically expect to support a position but who end up doing so (Glaeser and Sunstein 2014). A fervent believer in astrology who later becomes convinced that astrology is unscientific can function as a surprising validator, communicating to others her change of heart and the reasons for it.

If the results of the study by Lyons and collaborators are replicable and generalizable beyond GMOs, the skeptical community may want to consider harnessing conversion experiences as a persuasive strategy. Consider Janyce Boynton, once an ardent believer in the now convincingly debunked technique of facilitated communication (FC) for autism and other developmental disabilities. Boynton was once a trained facilitator; for readers who have seen the classic 1993 *Frontline* video, "Prisoners of Silence," Boynton was the facilitator in the Betsy Wheaton case, in which a sixteen-year-old girl with autism accused her father and brother of sexual abuse through FC. Following a series of controlled tests by Dr. Howard Shane of Boston Children's Hospital, which showed conclusively that she, not Wheaton, was authoring the messages, Boynton reluctantly decided to forgo FC and persuaded her school to stop using it. Two decades later, in a courageous 2012 article, Boynton wrote of her emotionally painful conversion experience, observing how difficult it was for her to surrender her initial beliefs in the wake of Shane's negative controlled tests:

> I felt such devastation, panic, pain, loneliness—a myriad of emotions difficult to put into words. The whole FC thing unraveled for me that day, and I did not have an explanation for any of it. Almost immediately, I started rationalizing away the truth. … I understand how difficult it may be for some facilitators to change their belief system. There is a lot at stake: people's careers, reputations, connections with their family member or client. Nonetheless, I urge practicing facilitators to take a long, hard look at their own behavior. (Boynton 2012, 11–12)

(Psychologist Stuart Vyse devoted his March/April 2019 Skeptical Inquirer "Behavior & Belief" column to Boynton and her case [Vyse 2019].)

Despite overwhelming scientific evidence that FC does not work, the method remains alive and well, and even seems to be mounting a comeback in some quarters under the guise of "rapid prompting method" and allied techniques that are minor variants of FC (Lilienfeld et al. 2014). Concerted efforts by skeptics to stem the tide of FC's popularity appear to have failed. It would be interesting to see if presenting committed FC believers with Boynton's compelling narrative would shake their belief certainty. More broadly, it would be useful for the skeptical community to gather similar conversion stories and determine whether they can be harnessed in the service of beneficial attitude change. ■

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Scott O. Lilienfeld is Samuel Candler Dobbs Professor of Psychology at Emory University in Atlanta and a visiting professor at the University of Melbourne (Australia). He is also editor-in-chief of *Clinical Psychological Science*. He is a fellow and member of the Executive Council of the Committee for Skeptical Inquiry.

Flat-Earth School Board Presentation Intelligently Designed

CRAIG A. FOSTER

The turf war over science education recently took a new turn. Marilyn Teed told the Methacton School District, outside Philadelphia, Pennsylvania, that it was teaching what could be an outright lie: that Earth is a sphere. She then explained, in all seriousness, her case that Earth is actually flat.

I'm going to defend Teed, but only to a degree.

I won't defend Teed about the shape of Earth. Earth is obviously spherical. I will spare all of us a review of the evidence. I will defend Teed, however, by pointing out that from the perspective of flat-earthers, her petition for less spherical Earth dogma in science education seems entirely reasonable. Her attempt to revise science education, after all, runs parallel to attempts made by other pseudoscientific communities.

I won't defend Teed about the shape of Earth. Earth is obviously spherical. I will defend Teed, however, by pointing out that from the perspective of flat-earthers, her petition seems entirely reasonable.

In fact, I anticipated Teed's flat-earth school board presentation months ago. *The Denver Post* published an article about a flat-earth–friendly group in Fort Collins, Colorado. In response, I cautioned that arguments in favor of making science education more accommodating to other forms of pseudoscience could be used to support flat-earth belief.

In particular, creationists have long argued that it is only fair to teach (false equivalence coming) both sides of a debate. In isolation, throwing creationists a bone might seem like a small kindness, one consistent with a long-standing national tradition of fair play and even dealing. But softening the principle of science-based science education in this way leads to what should be (I repeat: *should be*) obvious problems.

First, if science education is going to include non-science out of fairness, are all pseudoscientific claims going to be added? What's next? The Sun's rotation around Earth? The value of healing crystals in building resilience? The likely habitat of Bigfoot? Science textbooks could balloon from the pressure exerted by all the woo.

Second, assuming that science education cannot include every pseudoscientific claim, which claims merit inclusion? Don't ask me; I don't think that *any* pseudoscientific claims should be allowed to appear as scientifically credible. Nevertheless, I don't see any principled basis for allowing the nose of the camel while excluding the rest of the beast.

Third, how is the accommodation of pseudoscience fair to the people who do not believe in it? Religious people have a right to their beliefs but not to making children with different faiths or nonfaith learn them in public school. Likewise, teaching well-established scientific principles, such as humans' contribution to climate change, might strike some as politically disrespectful, but undermining those principles might similarly strike others as disrespectful.

Ideally we would anticipate how altering science education to include nonscience creates these types of problems and we would let science education be dictated solely by science. Clearly that isn't the case. Acquiescing to popular forms of pseudoscience can be seen in teacher reluctance to promote evolution and climate change. It can also be seen in the recent arguments in Arizona orbiting the wording in proposed state science standards.

The flat-earth presentation provides a practical case that should help demonstrate the folly of giving into popular pseudoscientific sentiment. Few peo-

ple would agree that science education should decrease its emphasis on the spherical Earth, but this type of reaction is easy to generate because flat-earth beliefs are uncommon. This stands in contrast to the relatively greater number of creationists who believe that Earth is 10,000 years old or younger. If Teed had been promoting the young Earth, rather than the flat Earth, fewer people would think she had left planet Earth.

More to the point, I do not see a principled basis for accommodating creationism and climate change denial but not the flat Earth. If it is only fair to hear "both sides" of a science-pseudoscience "debate," then children should learn arguments in favor of Earth being spherical *and* being flat. Flat-earthers could even argue that omitting their viewpoint is unfair to their right to religious freedom, given their common use of the Old Testament as support for their views (e.g., Daniel 4:11).

It might be tempting to argue that flat-earth belief is different because it is *so obviously* false. This argument doesn't make any sense either. Scientifically speaking, creationism, climate change denial, and the flat Earth can all be described as untenable, even if one could distinguish one group as more pseudoscientific than another. Put differently, creationism, climate change denial, and the flat Earth all belong to the same family, even if they are different species. Besides, it seems odd to suggest that science education should accommodate pseudoscience, so long as the claim isn't *too* pseudoscientific.

Why, then, is Teed's flat-earth proposal roundly rebuked, whereas similar proposals on behalf of other forms of pseudoscience are taken more seriously? It's only because those other forms of pseudoscience have, at present, a great deal more support—support that allows believers to exert influence on science education administrators or elect sympathizers to local school boards or state boards of education.

This double standard of principle is unfortunate and dangerous. It is unfortunate because it allows the United States to degrade a science education that we justifiably celebrate. It is dangerous because we rely on science to solve social problems, problems that in at least one case could extinguish the human race if we are neglectful or unlucky.

Besides, it is the principle of keeping science education based solely on science—regardless of its popularity—that keeps the flat Earth and similar flim-flam on the outside looking in. Soften that principle and who knows? Some evidence suggests that the flat-earth movement is growing. Maybe future lesson plans will be less compelling in their description of the spherical Earth.

Considering the latitude afforded to other forms of pseudoscience, it would only be fair. ■

Craig Foster is a psychology professor in the Behavioral Sciences and Leadership Department at the United States Air Force Academy. His research focuses on scientific reasoning and the development of pseudoscientific beliefs.

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Joe Nickell, PhD, is CSI's senior research fellow and author of some forty books, including *The Science of Miracles*.

The Trapped Miners' Holy Visions: Investigating the Sheppton 'Miracle'

On August 27, 1963, two Pennsylvania coal miners were rescued after two weeks of being trapped underground. The pair would soon relate how, confined in the pitch black, they had witnessed humanoid figures, bathed in strange light, and saw a door that opened onto marble steps leading to a great celestial city with angels playing harps. Pope John XXIII, who had died just ten weeks before, smiled down upon the two.

Skeptics of these supposedly miraculous "visions" branded them "delusions" and "hallucinations," but defenders of the claims observed that "both men had independently corroborated the other's story" (Furek 2015, 128). As one of the two stated, "They now tell me these were hallucinations but the crazy thing is that Davey [the other miner] would see the same things I did" (Throne quoted in Furek 2015, 129). Even when both were interviewed separately, they still related in detail the very same story (Budd 2013). How could this be? Were the visions indeed proof of heaven, evidence of life after death, or at least substantiation of near-death experiences? If not, then how do we explain these reported claims of the inexplicable?

Collapse!

The remarkable story of the trapped miners and their "supernatural" visions began on Tuesday, August 13, 1963, at the village of Sheppton, Pennsylvania, with the collapse of the roof of the anthracite coal mine operating there. The cave-in was triggered when a cable hoisting a heavily loaded coal buggy snapped, sending the vehicle careening downward and ripping out support beams. Three miners—David Fellin, Louis Bova, and Henry "Hank" Throne—were trapped. Fellin and Throne had been on the opposite side of the railway tracks from Bova, who was only heard from briefly. Subsequently, the others lost all contact with him, and his body was never recovered.

Soon, the two survivors' lights gave out, leaving them in that absolute darkness occasionally experienced by miners and underground workers. (As a young spelunker, I once had my carbide light go out at an inopportune moment when climbing down a well-like shaft! [Nickell 2017a, 12].) Being trapped would be awful in itself; being trapped in utter darkness would be nearly unbearable.

The two were also cold, and during their ordeal they slept face to face with their arms around each other. They would sleep fitfully until again awakened by the cold. Dave Fellin took care of the younger Hank Throne, who developed a symbiotic relationship with his more mature and experienced partner. Throne would come to believe that Fellin saved his life (Furek 2015, 37, 43–44, 84).

The Rescue

Meanwhile, authorities above ground put aside their initial skepticism and brought in specialized drilling equipment. They began with two boreholes, six inches wide, and used them to determine if the men were still alive. After six days that proved successful: the drill broke through the roof of the men's dark chamber, and a shout down the borehole yielded a response! The trapped men soon received water, food, and medication. A microphone was lowered, and amplifiers permitted the two to talk with family members. A hospital tent was set up and manned by a U.S. Navy physician.

Now, an even more massive drill would be used to enlarge the small borehole. It was provided by billionaire Howard Hughes and flown to a nearby airport by a Navy plane, then transported to the site on a flatbed trailer in a convoy of other vehicles and Pennsylvania state troopers.

The special rig began drilling on August 20, and it ended on August 27. The borehole, just 17.5 inches in diameter, proved more jagged than intended, so, when each man donned his specially prepared harness-and-coveralls outfit, he was coated with axle grease to assist him in sliding through the long, narrow hole. Fellin insisted that the younger and more emotional Throne be lifted out first. Then the wench drew him up the more than 300 feet to freedom—an excruciating and claustrophobic experience (Furek 2015, 55–81).

The Visions

Following their arduous and dramatic rescue, Dave Fellin and Hank Throne told their remarkable story to medical survival experts as well as to a spell-

bound public. Of special interest, and controversy, were the claims of supernatural involvement—prompted by the remarkable visions the trapped men had witnessed.

They recollected the humanoids who were dressed in space suits with lights on their helmets. Revealingly, the two miners felt strangely wonderful and seemed to be in a dream state, like traveling through a hall of mirrors. Throne yelled to one figure, "Show me some light over here! Over here!" Fellin saw him too, he said, "but the shape of the man got smaller and smaller as we crawled toward him and then he was gone altogether" (quoted in Furek 2015, 121–122).

Author Furek (2015, 122) asks sensibly, "Was it but an illusion; a stairwell never to be touched or walked upon? Was it the stark denial of reality, an abdication of the laws of nature? Were these revelations a confabulation of a traumatized mind?"

Seemingly, defeat, hopelessness, and fear—an unrelenting primal fear—had set in, turning into a deadening phenomenon termed "miner's psychosis," when reality gives way to mind-altering terror (Furek 2015, 39). Symptoms of psychosis include delusions (false beliefs) and hallucinations (seeing or hearing things that others do not).

My longtime fellow investigator and best friend, the late psychologist Robert A. Baker, observed that hallucinations "can occur in people who are subjected to abnormal environmental conditions such as prolonged sensory deprivation, sleep deprivation, starvation, and severe stress, as well as fatigue and grief" (Baker and Nickell 1992, 18–19). Even "normal people can also hallucinate without being judged psychotic," he noted (Baker 1996, 229). In a wide-ranging discussion of hallucinations and delusions, Baker (1992, 281, 286–87) noted that expectation—indeed "the self-fulfilling prophecy mechanism"—perpetuates delusional beliefs. Moreover, he added, "We sometimes use our imaginations to create events that are self-serving and then we proceed to forget they are imaginary since the self-deception now serves us so well."

We can see that the case of the two trapped miners at Sheppton demonstrates the application of those principles. As Baker (1992, 270–71) observed, "Meeting with hallucinated entities occurs in circumstances of extreme stress"—just the condition the miners were experiencing. Moreover, their reported fantasy beings and scenes are reminiscent of the visionary effects of so-called near-death experiences (NDEs). The miners, like near-death experiencers generally, were not actually near death; rather they were surely suffering additionally from oxygen deprivation, which can cause hallucinations (Ebbern et al. 1996, 31). States Furek (2015, 29), the two "were choking on polluted air unfit for human beings."

Times-Shamrock Newspapers

David Fellin, left, and Hank Throne after the rescue.

Seeming to confirm the hallucination hypothesis is the fact that the miners' visions comprised little more than the rather hackneyed images of Christian iconography: a doorway onto heaven (Revelation 4:1), heaven seen as a great Golden City, and apparitions of the deceased Pope John XXIII, as well as of angels and children playing harps (Furek 2015, 76, 122, 123, 156, 164).

The image of the Pope suggests a Catholic view, and indeed David Fellin was a Roman Catholic. Christian imagery would have been stored deep in his subconscious, and belief in the reality of visions was a mainstay of his faith.

Hank Throne, on the other hand, was not especially religious, and he did not know who Pope John XXIII was or that he was deceased. So how did the two men reportedly see the very same visions at the same time? Paranormal editor Deena West Budd concluded, "As both parties were interviewed separately, yet reported the same story, I tend to believe it was NOT a hallucination" (Budd 2013). Other sources confirmed that "both men had independently corroborated the other's story" (Furek 2015, 128).

An article in *Fate* magazine emphasized that the visionary phenomenon was both "continuous" and "collective," and one "unmatched in the annals of psychic research." The writer had independently interviewed each man without the knowledge of the other, and he felt strongly that the two had *not* spent time "putting their views into agreement." David Fellin had himself told the *Fate* writer:

> Pope John and the cross was there all the time. But these other things kept jumping across. First there was these

> men with lights and after awhile the steps would come. … It was real. Both of us were seeing it and we knew they was live people. We know that. (quoted in Schmeer 1965, 28–29)

So how was this possible?

A Solution

We can begin an answer by considering a phenomenon known as *folíe à deux*, a French term meaning the "folly of two."[1] What can happen with supposedly shared visions is that the more dominant personality—highly imaginative and convinced of the reality of his hallucination—causes the less dominant one, through the power of suggestion, to imagine that which is being described to him (Baker and Nickell 1992, 129). Voila! A shared vision.

(I once encountered a good example of this phenomenon at the supposedly haunted Buford's Tavern in Virginia—central to the famous Beale Treasure legend. The owner and his wife had had the striking experience of together witnessing a ghost on the stairs. However, they were lying in bed, in a state between being fully awake and asleep, one known to produce hallucinated sounds and images. As they began to exchange impressions in their suggestible condition, they soon were sharing a dreamlike occurrence—first, creaking sounds described as like someone walking on the stairs, then the image of a figure soon *imagined* to be the fictitious Thomas Jefferson Beale. The incident had occurred many years before, but the man, now a widower, recalled the details so clearly to me that I could understand it as an obvious case of *folíe à deux* [Nickell 2017b].)

There is evidence that this is what actually happened with the two trapped miners. As noted earlier, Fellin was by far the more dominant personality—older, more experienced, and more confident. Furek (2015,62) states:

> Fellin was the acknowledged leader. … Four decades of experience, information and possible strategies gave him an inner peace and confidence. Fellin was steady as a rock, and Hank Throne recognized that … , acknowledged that Fellin possessed more character and resilience than he could ever dream of … . He knew that his only chance of survival was by following Fellin's lead.

It was obviously Fellin who initiated the visions. Only he could mention and describe Pope John XXIII, because Throne had known nothing of him. Fellin was the driving force, even having had out-of-body experiences in which he seemingly rose above the mine to supposedly look down upon the rescuers. This happened to him many times, while Throne experienced that phenomenon a single time (Furek 2015, 133).

There is also evidence that the visionary images were not viewed identically. For example, a cross seen with the first appearance of the Pope was described quite differently by the two: Fellin's cross had squared ends and its transverse beam curved upward at each end, whereas Throne's cross had rounded ends and the transverse beam curved up on one end and down on the other (Schmeer 1965, 33–34). These discrepancies are consistent with one man initiating the vision and the other picturing details of what he "saw" in his own imagination.

As another example, their descriptions of the marble stairs also varied considerably. Fellin said the marble steps were some ten to twelve feet wide and continued far up until they went out of sight. Throne, however, described them as only "three to four people wide" and recalled them as numbering just twelve to fourteen. Yet again, while both men agreed that three humanoid beings came to them with a tablet or plaque showing they would survive their ordeal, their descriptions of this plaque were quite different. In Fellin's version, the plaque was rectangular and about eight by eleven inches, whereas Throne said it was triangular, nearly heart-shaped, and was approximately sixteen inches long by twenty-four inches wide (Schmeer 1965, 34–35).

These and other mismatches are telling. They reveal that while the main forms and actions are in general agreement, just as they could be expected to be (the result of one person relating what he perceived to another), the details—while specifically noted—are quite different, consistent with each man imagining them for himself.

Taken together, the different bits of evidence demonstrate that the men's visionary experiences were, understandably, almost certainly hallucinations, delusions, and imaginings, shared through suggestion so that eventually they became more or less standardized between the two trapped miners. This probability is both plausible and corroborated by evidence, whereas the alternate explanation—that the described visions were actual supernatural occurrences—loses out to the principle of Occam's razor, the scientific rule of thumb that suggests the hypothesis with the fewest assumptions is to be preferred. (Positing the supernatural requires assumptions not founded in science.)

This is not an unscholarly "debunking" attitude but rather an investigative one. I remain confident that an investigation leading to explanation is the best approach. If something can be effectively explained, any needed debunking will take care of itself. ■

Note

1. If more people are involved, the phenomenon can be called *folíe à trois*, *quatre*, *cinq*, etc., as needed.

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NOTES ON A STRANGE WORLD] MASSIMO POLIDORO

Massimo Polidoro is an investigator of the paranormal, lecturer, and cofounder and head of CICAP, the Italian skeptics group. His website is at www.massimopolidoro.com.

The Mind of Leonardo da Vinci, Part 2

It may be worth considering what it means to "go against the flow" in science.

What makes a genius rather than a mere mortal or, worse, a fool? Think of Mozart or Van Gogh, artists who revolutionized music and painting. In the arts, genius has often been associated with the idea of the artist's opposition to social norms; examples abound, from Picasso to Pollock, Elvis to The Beatles. In art, a good artist is often a rebel. But what about science?

Even though science appears to be a more rational and cautious activity compared to the arts, the link between rebellion and scientific creativity is maybe even more revolutionary.

When Galileo said that Earth was not at the center of the universe and that it was not true that the cosmos gravitated toward it, he was not going against fashions or habits; he was going against very strong beliefs, cemented over the course of 2,000 years of history. Aristotle had stated how the universe worked, and his ideas had been repeated until Galileo and Copernicus, with their telescopes, demonstrated that he was wrong. Or consider Charles Darwin, whose discoveries further demolished the religious-based image of a "special creature" among animals that man had painted for himself.

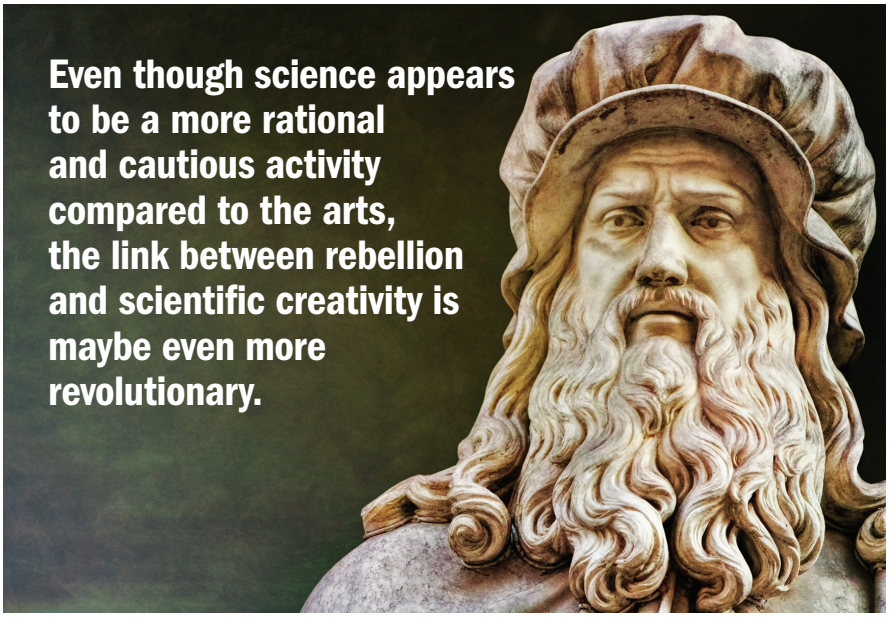
The reactions to such revolutions were not mere critiques: Galileo was put under inquest by the Inquisition and was forced to recant to save his own life. Darwin was luckier, for in his time, the Inquisition had been abolished.

What is important is that their discoveries have been validated and their values confirmed by those who came after them. This not only gave strength to such discoveries but established an idea central to science: the words of an authority have no value unless they are supported by facts. Facts that are verifiable and repeatable are the only things that matter.

Plato wrote that scientific truths are eternal and never change; it is not so. As we know, they are considered true until they are shown to be false by contrary experience. And this is why Leonardo da Vinci represents a fascinating example of someone who understood this principle long before many others did.

Leonardo admitted he was "a man with no letters," meaning that he did not have a formal academic history. He had been an apprentice at Verrocchio's shop, along with other kids such as Domenico Ghirlandaio and Sandro Botticelli—some of the greatest painters of the Renaissance. This lack of proper, codified education had been to his benefit; he called himself a "disciple of experience."

Leonardo used to say that every argument that is not born from experience is vain. "Avoid the rules stated by those who do not confirm their ideas with


Even though science appears to be a more rational and cautious activity compared to the arts, the link between rebellion and scientific creativity is maybe even more revolutionary.

experience," he wrote. Nothing that has not been demonstrated by facts can bring any good to man or to his progress. This is the reason he was rarely wrong; he never forced facts to accord with the hypothesis that he cared about. Instead, he let the experience show him the way.

We can find an example of this in his studies of the circulation of water on Earth. In one of his manuscripts dated 1508, he opens with the analogy between the small world of man and the big world of Earth. He writes, "Similarly to men and animals, the body of the Earth is crossed by veins—the waters—that nourish the land and its creatures." He had gotten this analogy from Vitruvius, the famed Roman architect and engineer. It was an analogy that agreed with the idea that man was at the center of everything.

It was a fascinating idea, but "experience" was ready to change everything. Leonardo was not one who would simply accept what others had said; he wanted to understand and check it out for himself. So, if he was comparing man and Earth, he had to know exactly how man and Earth worked. He did so with his anatomies of dead bodies. And to understand nature, he explored the inside of mountains, collected fossils … and, by the way, was among the first to understand that they were not proof of the universal flood—which he did not believe in—but rather proof that the surface of the earth was very different in ancient times, when water was where mountains are now. The facts he was able to gather showed him that this analogy was untenable and does not correspond with reality, since water does not go back up into mountains the way blood continually flows inside the body.

The words of an authority have no value unless they are supported by facts. Facts that are verifiable and repeatable are the only things that matter.

So, Leonardo abandoned this idea and tried other ways of reasoning and, eventually, by the end of his manuscript, we find that his ideas took him to what we now know is the correct answer: water reaches the mountains because it evaporates, rising in the air, forming clouds that then rain back down on the earth.

The fact that Leonardo did not satisfy himself with the most comfortable explanations but was constantly searching for truth and putting every hypothesis to the test allows us to consider Leonardo's method a precursor of the scientific method, as were Galileo's and Descartes's later.

At the end of his life, Leonardo left Italy and went to France, where he had been invited by the king, along with his trusted disciple Francesco Melzi. When Leonardo died on May 2, 1519 (aged sixty-seven), he left all his manuscripts to Melzi, with whom he had spent the last thirteen years of his life. Melzi preserved them with affection, like precious relics, but after his death many of those papers were lost.

One apt description of Leonardo was probably very frustrating for him; he was a man who woke up in the middle of the night, too early, while everybody else around him was still asleep. ■

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[REALITY IS THE BEST MEDICINE HARRIET HALL

Harriet Hall, MD, also known as "The SkepDoc," is a retired family physician, a CSI fellow, and an editor of the *Science-Based Medicine* blog. Her website is www.skepdoc.info.

Too Many Medical Tests

Doctors order too many tests. Some are useless, some are harmless (except for the cost), but some can lead to serious bodily harm.

Misconceptions about Tests

Many people, including doctors, tend to think of tests as giving consistent and reliable yes or no answers. They think a test can make a diagnosis, but that's not how it works. It's much more complicated than that. Medical history and physical examinations are more important; tests only contribute around 10 percent to the diagnostic process. Misconceptions about tests abound. Here are some examples.

MYTH: A normal lab value is the same everywhere.

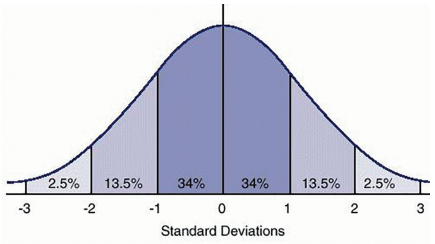
Reality: Different labs have different normal reference ranges. The Cleveland Clinic website defines a normal hemoglobin for a man as 14–18 grams per deciliter and for a woman, 12–16 grams per deciliter. Another website defines normal as 13.5–17 and 12–15. And the lab at Madigan Army Medical Center, where I get my medical care, has a reference range of 10.0–15.0, sex not specified. Normal reference ranges are different for children and pregnant women and may differ slightly for different racial groups. The source of the sample matters: blood from a fingerstick, for example, will give a higher cholesterol reading than blood from a vein.

MYTH: Test results are consistent and reliable.

Reality: If you repeat a test, you will get slightly different values each time. The hemoglobin may be 14 grams per deciliter today, 14.7 tomorrow, and 14.3 the following day. Even repeating a test an hour later may give different readings. There are many reasons for the discrepancies. Many lab chemistry values are subject to diurnal variation: it makes a difference what time of day the blood was drawn. Dehydration will alter results. If the blood sample is too small or is not properly anticoagulated, it may give false hemoglobin readings. The automated machine may be faulty or not properly calibrated. A laboratory technician may have made a mistake, switched samples, or recorded the results incorrectly. My mother was falsely diagnosed with diabetes on the basis of a single blood test; subsequent tests were all normal.

MYTH: "Normal" is determined by rational, science-based, physiological principles.

Reality: To determine normal values, many normal people are tested. This generates a spectrum of values distributed in a bell-shaped curve. Values



RULES OF THUMB FOR PATIENTS:

Never believe a single lab test.

Understand the reason for the test, the pros and cons, and whether it is likely to help establish a diagnosis or alter management.

Refuse tests that are not indicated.

within two standard deviations of the mean are called normal; the 2.5 percent on the low end and the 2.5 percent on the high end (the "tails" of the bell curve distribution) are called abnormal. So 5 percent of normal people will have abnormal test results simply because of the way normal is defined. And because of this, if you do multiple tests on a perfectly normal individual, statistics predict that one in twenty will give a false positive result. This may be a problem with automated analyzers that do whole panels of tests: when one blood chemistry is ordered, a lot of other tests come along for free.

MYTH: Doctors have good reasons for ordering tests.

Reality: Sometimes doctors have no idea what is wrong so they embark on a fishing expedition, ordering a battery of tests in the hopes that something abnormal will turn up that will give them a clue. As I explained above, statistically this will result in 5 percent false positive results, which may mislead the doctor and initiate a wild goose chase of other tests that were not indicated, sometimes even invasive tests such as biopsies and exploratory surgeries with the potential to harm or kill the patient. Sometimes doctors order a test out of insecurity to bolster their confidence in a diagnosis they have already made and are treating with good results. Sometimes they want to be thorough and make sure they haven't missed anything. Sometimes their motivation is to avoid malpractice lawsuits. Sometimes they order a test out of pure curiosity; for example, they may wonder what the hand X-ray looks like in a patient with arthritis when the arthritis is responding well to treatment—though the X-ray findings would not change management.

MYTH: Imaging tests and biopsies are foolproof.

Reality: X-rays, CT scans, MRIs, Pap smears, microscope slides from biopsies, etc., have to be interpreted by fallible humans, and the signs are not always clear-cut. Judgment is involved. Experience matters. People make mistakes. They disagree about findings. They tend to see what they are looking for and miss other findings. A classic illustration of this was an experiment where a matchbook-sized image of a gorilla was superimposed on chest X-rays: 83 percent of radiologists missed the gorilla because they were fixated on finding cancer nodules in the lungs.[1] You can find it online; you will be amazed that anyone could miss the gorilla.

Many lab chemistry values are subject to diurnal variation: it makes a difference what time of day the blood was drawn.

Incidentalomas

Unexpected findings (incidentalomas) are very common in imaging studies.

Fifteen percent of CT scans detect incidentalomas in the liver; 8–51 percent detect nodules in the lungs; 50 percent of patients have thyroid nodules; 10 percent of patients have pituitary incidentalomas; and about half of virtual colonoscopies detect abnormalities outside the colon. The majority of these findings (perhaps 99 percent) are benign, will never cause symptoms, and do not require further evaluation. But you can imagine how patients will worry about what that nodule or cyst inside their body might really be. Clinicians are developing guidelines to help them decide whether to ignore, follow, or pursue a diagnosis in incidentalomas of various organs.[2]

Screening Tests

Screening tests sound like a good idea: test people before symptoms develop to detect problems and treat them early. The problem is screening tests involve harms as well as benefits, and if the prevalence of the disease in the population being tested is low, false positives will far outnumber true positives. In a previous issue of Skeptical Inquirer (January/February 2019), Felipe Nogueira wrote about screening for prostate and breast cancer, explaining that some patients are diagnosed and treated needlessly and suffer harm from the treatments.

The U.S. Preventive Services Task Force (USPSTF) is an independent panel of experts that systematically reviews all the evidence and makes frequently updated recommendations for screening. Each test is categorized

as Recommended, Recommended Against, or Insufficient Evidence to assess balance of benefits and harms.

Various companies and healthcare providers offer screening tests that are not recommended by the USPSTF and are not covered by insurance. One of the biggest offenders is Life Line, which advertises deceptively, sets up in churches or other community buildings, and offers non-recommended ultrasound screening tests to the general public. They are essentially selling FUD (fear, uncertainty, and doubt). Doctors have to pick up the pieces and reassure Life Line's worried customers that no, they are not in danger.

In recent years, whole body scanning became a fad. It was offered directly to the general public in free-standing CT clinics. The idea was to screen for cancer anywhere in the body. But it was not good at finding cancer. It exposed patients to radiation, was costly, found lots of incidentalomas, and did more harm than good. Fortunately, the fad seems to have died out.

Patient Demands

Poorly informed patients may demand that their doctors do specific tests that are not medically indicated. For instance, they may read online that they should insist that their doctor check their erythrocyte sedimentation rate and C-reactive protein. Those are both nonspecific inflammatory markers that go up in many different conditions. A normal test result can rule out some things, but an abnormal result doesn't tell you what is causing the inflammation, and the people who recommend screening don't really know what to do when the test is abnormal.

Many years ago, I had a patient who insisted on monthly cholesterol tests and agonized about her diet if her numbers had gone up by even a point or two. She failed to understand that they were just meaningless fluctuations, noise in the data. Today we would have given her statin drugs and not done any further cholesterol tests; we have learned that following the lipid levels is pointless.

Routine Physicals

We used to get annual physical exams, with blood tests, urinalyses, chest X-rays, TB tine tests, and so on. These are no longer recommended because they have been shown not to improve outcomes. It's still a good idea to have a yearly "health maintenance" appointment with your doctor. It's a chance to ask questions about health concerns, to monitor blood pressure and weight, to see that immunizations are up to date, and to ensure USPSTF screening recommendations are followed. But the physical exam itself can be omitted. It's not useful to look in every asymptomatic patient's ears, listen to his or her lungs and heart, or palpate his or her abdomen. What *is* useful is a directed physical exam to address any symptoms. Pap smears are useful to screen for cervical cancer, but the bimanual exam with palpation is not productive for asymptomatic women, and a pelvic exam is no longer required for prescription of oral contraceptives.

Life Line essentially sells FUD (fear, uncertainty, and doubt). Doctors have to pick up the pieces and reassure Life Line's worried customers that no, they are not in danger.

Executive Physicals

The executive physical goes far beyond the standard annual physical, with a battery of tests that supposedly provide better health care for VIPs. It may make the recipients feel special, but good health care should be the same for everyone, and the executive physical can do more harm than good. Just one example: many years ago, a general in the U.S. Air Force mentioned during his annual physical that he occasionally got headaches. They were garden-variety tension headaches; only reassurance and analgesics were indicated. But because of his high rank, he got a thorough neurologic workup, complete with an invasive test that caused a fatal stroke.

Functional Medicine

The worst offender for unnecessary tests is functional medicine. As David Gorski explains, "functional medicine" is a form of quackery that combines conventional medicine and alternative medicine. "Specifically, it combines massive over-testing with a lack of science and a 'make it up as you go along' ethic, all purportedly in the service of the 'biochemical individuality' of each patient."[3]

Dr. Gorski describes how functional medicine treated an elderly woman with breast cancer. On top of conventional oncologic treatment, the functional medicine doctors prescribed a lot of useless treatments and tests. She got ninety-seven intravenous infusions of vitamin C plus multiple oral supplements (including more vitamin C!), and they did enough nonstandard tests to take up two full pages of the case report.[4] They included amino acid levels, "gut immunology" markers, secondary bile acids, parasite tests, pancreatic enzyme levels, heavy metal levels, oxidative stress markers such as glutathione and coenzyme Q_{10}, and much more. My favorite: the "urine representativeness index." None of these tests were indicated. And if a result was abnormal, there is no science-based guidance on what to do about it or, indeed, whether anything needed to be done. ■

Notes

1. https://www.npr.org/sections/health-shots/2013/02/11/171409656/why-even-radiologists-can-miss-a-gorilla-hiding-in-plain-sight
2. https://www.aafp.org/afp/2014/1201/p784.html
3. https://sciencebasedmedicine.org/functional-medicine-in-practice/
4. http://imjournal.com/openaccess/taxman151.pdf

Stuart Vyse is a psychologist and author of *Believing in Magic: The Psychology of Superstition*, which won the William James Book Award of the American Psychological Association. He is a fellow of the Committee for Skeptical Inquiry.

National Down Syndrome Society Promotes Communication Pseudoscience

On January 10, 2019, the National Down Syndrome Society (NDSS) offered a free public webinar on facilitated communication (FC), a thoroughly discredited communication method most often used with people who have autism. The webinar, "Facilitated Communication and Down Syndrome," was sponsored by NDSS's Inclusive Education Taskforce and was led by Christy Ashby, PhD, director of the Institute on Communication Inclusion—formerly known as the Facilitated Communication Institute—at Syracuse University.

Facilitated Communication

As readers of this column will recall (Vyse 2018), FC is based on the theory that many people with profound language deficits suffer from a physical problem—an inability to produce the sounds for speech or the movements required for writing or typing—but are not cognitively impaired. According to this theory, these individuals can't get their ideas out of their broken bodies. FC supporters claim this problem can be solved by having another person—a facilitator—hold the student's hand or arm and guide it over a keyboard. If the facilitator could just steady the nonspeaking person's hand, the intelligence hidden within could emerge. In the early 1990s, FC spread rapidly, and with the help of their facilitators, many previously nonspeaking people began writing poetry and performing at grade level in school. Some of them even went on to attend college accompanied by their facilitators.

But in the early 1990s, the first empirical tests of FC began to appear, and the results were devastating. In every case, double-blind studies revealed that the facilitator—the disabled person's helper—was doing the typing, not the person with autism. It was a Ouija board–like phenomenon, and the facilitators appeared to be entirely unaware that they were the authors of the words on the computer screen. Since then, a number of systematic reviews of the evidence have come to the same result: FC doesn't work (Mostert 2001; Mostert 2010; Schlosser et al. 2014).

Facilitated communication was a Ouija board–like phenomenon, and the facilitators appeared to be entirely unaware that they were the authors of the words on the computer screen.

Down Syndrome

Down syndrome is a genetic disorder that affects approximately one in a thousand births worldwide (Weijerman and De Winter 2010). Typically, the nucleus of each cell of the body (other than in the sperm and eggs cells used in reproduction) contains twenty-three pairs of chromosomes. In its most common form, Down syndrome, also known as trisomy 21, is produced when a child's cells show an extra chromosome or partial chromosome in pair 21. Children with Down syndrome have characteristic physical features, including low muscle tone, small stature, and an upward slant to the eyes, and they experience substantial learning challenges. A recent survey of adult Americans with Down syndrome found that 57 percent were in paid employment but only 13 percent worked twenty-one hours a week or more (Kumin and Schoenbrodt 2016). The cause of Down syndrome is still unknown, and the most important known risk factor is maternal age, with increased incidence in mothers over the age of thirty.

The NDSS Webinar

NDSS, which was founded by two parents of a Down syndrome child in 1979, is one of two national Down syndrome societies in the United States. The other is the National Down Syndrome Congress, founded in 1973. NDSS describes itself as "the leading human

rights organization for all individuals with Down syndrome." Both organizations offer educational programs for parents, sponsor an annual conference, and lobby for legislative support of people with Down syndrome.

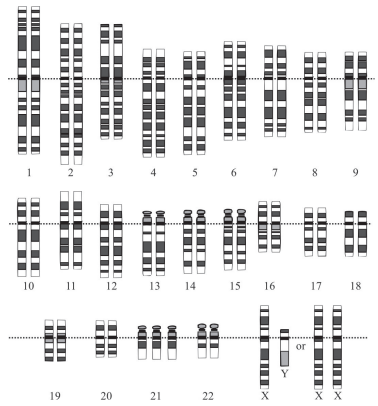
The NDSS FC webinar was set up as a narrated slide show. Participants who logged in on their computers saw Ashby's slides and heard her voice but could not see her. In addition, participants could type questions for the speaker to answer. There were the usual number of technical problems, and, unfortunately, only Ashby could see the questions participants posted. There was no opportunity for real dialogue.

The webinar began with some quotes reputedly from people who use FC to communicate, and, in many cases, Ashby reported that some of these individuals now typed independently and could read what they had typed. However, it was not clear whether the quotes presented were written with a facilitator or independently. Many of the quotes were about how these individuals had suffered discrimination and believed they had a fundamental right to communicate. Others described the physical problems they faced in an effort to get their words out.

Ashby's presentation had all the earmarks of a belief system rather than a description of an educational technology. She repeated a popular motto of the modern FC movement, "presume competence," and she repeated the word *believe* several times in her presentation. Furthermore, she expanded the idea of presuming competence, asserting that it was also important to "constructing competence": "It is not enough to believe people are capable of communicating; there are things we need to do … . So, constructing competence is something that requires action."

As this quote suggests, Ashby encouraged facilitators (a) to believe these nonspeaking individuals have the ability to communicate, and (b) to be active when helping them—a combination that is likely to lead facilitators to control the typing while believing they are not.

In addition to encouraging belief in the technique, recent strategies for promoting FC have turned it into a social movement. In her introduction to the quotes from FC users, Ashby invoked the disability rights motto, "Nothing about us without us." This phrase expresses a reasonable demand that affected people be included in the design of policies and adaptations for their benefit, but when we are talking about the statements of nonspeaking people obtained using FC, it is not clear the "us" is them. It seems important to point out that substituting another person's opinions—the facilitator's—for the nonspeaking person's is no better than leaving them out of the discussion entirely. It is perhaps worse.



Karyotype of a person with Down syndrome showing three copies of chromosome 21. (Source: Wikipedia)

The social movement approach to promoting FC has many features. For example, an increasing number of people with autism freely adopt autism as a feature of their identity. Many years ago, professionals were urged to say "person with autism," rather than "autistic person." The latter was thought to define the person by their diagnosis—turn them into their diagnosis—whereas a person with autism was a person first. Recently this idea has been reversed. Members of the Autism Self-Advocacy Network, an active autism rights organization, and others have embraced the autistic identity. Similarly, in talking about Jamie Burke, a famous FC user who graduated from Syracuse University, Ashby said that Burke "identifies as autistic."[1] The adoption of an autistic identity is also consistent with the civil rights approach to advocating for people with autism, and as a result many messages obtained through FC describe the forms of discrimination the individual has suffered. In an extreme form of the civil rights approach to promoting FC, at least one advocate has asserted that opposition to FC is a form of hate speech (Stubblefield 2011).

Several critics of FC, some of whom were members of the True Voices group described in an earlier column (Vyse 2018), enrolled in the NDSS webinar, and to her credit, Ashby responded to a few critical questions. When asked about the "controversy" surrounding FC, she asserted that "actually the studies have been mixed," and she offered to supply the questioner with studies that support FC. Of course, the studies that provide a test of authorship of the messages are not at all mixed.

One exchange was particularly interesting: A questioner asked, "What would it take to convince you that FC doesn't work?" In a move reminiscent of Supreme Court Justice Brett Kavanaugh's confirmation hearing interchange with Senator Amy Klobuchar, Ashby avoided answering by turning the question back on the questioner: "What would it take to convince people that for this individual it *does*?" Unfortunately, due to the webinar format, the questioner could not easily respond, but there was an obvious answer: "I would be convinced if the individual could pass a simple double-blind test similar to the ones used in other evaluations of FC." All the published studies of FC that have used double-blind tests of authorship have shown that the facilitators—not the disabled individuals—were controlling the typing.

Ashby took another question from a participant who asked about a recent policy of the American Speech-Language-Hearing Association (ASHA) that opposed the use of Rapid Prompting Method (RPM), a variant of FC (American Speech-Language-Hearing Association n.d.). ASHA, like a large number of other professional organizations (Behavior Analysis Association of Michigan n.d.), had previously released a policy statement against the use of FC. Ashby acknowledged the

new ASHA policy but was encouraging, suggesting that different school systems were looking to their speech therapist professionals—some of whom are using FC or RPM—for guidance: "I am working with lots of schools in the area, and they're certainly aware of the ASHA statement. But they also believe very strongly that this is a human right and a civil right for students."

Based on this remark, it appears that some speech therapists are continuing to use FC and RPM in opposition to the recommendations of their professional organization.

In addition to encouraging belief in the technique, recent strategies for promoting FC have turned it into a social movement. In her introduction to the quotes from FC users, Ashby invoked the disability rights motto, "Nothing about us without us."

Although FC and RPM are most often associated with autism, this is not the first time these techniques have been promoted for children with Down syndrome. Back in the early 1990s, when FC was new, its proponents suggested it might be useful for children with Down syndrome, and in 2005, Christine Tracey (2005) wrote an article in *Down Syndrome News and Update* about what she believed was a successful implementation of FC with her son Matteo. The family lived in Rome, Italy, where Matteo attended school with a facilitator. In addition, Ashby quoted an FC user with Down syndrome named Mary, also Italian, who used FC. Finally, Ashby suggested that FC could be used with any number of conditions that shared a lack of speech ability. The first step was to presume competence.

Given NDSS's mission of being "the leading human rights organization for all individuals with Down syndrome," it is not surprising the organization supports a communication method that Ashby described as a "human right and a civil right." Nonetheless, it is unfortunate that a leading Down syndrome advocacy group is promoting a belief system over evidence-based methods that work.

A New Review of FC

All of this is somewhat ironic because less than two weeks before the NDSS webinar, a new review of research on FC was published in the peer-reviewed journal *Autism & Developmental Language Impairments* (Hemsley et al. 2018). Since FC was introduced in the early 1990s, there have been a series of systematic reviews of the research on FC. Hemsley and colleagues covered the period between 2014 and 2018, and their conclusions were not at all ambiguous:

> There are no new studies on authorship and there remains no evidence that FC is a valid form of communication for individuals with severe communication disabilities. There continue to be no studies available demonstrating that individuals with communication disabilities are the authors of the messages generated using FC. Furthermore, there is substantial peer-reviewed literature that is critical of FC and warns against its use. (Hemsley et al. 2018, p. 2)

This does not sound like the "mixed" research results Ashby referred to. When you compare the findings of this study with the NDSS webinar presentation, it is hard to avoid the conclusion that those who conduct rigorous, peer-reviewed research on FC live in a very different world than the NDSS, Christy Ashby, and the Syracuse University Institute on Communication Inclusion. ■

Note

1. In contrast, the NDSS does not support Down syndrome as an identity. Their Preferred Language Guide (National Down Syndrome Society n.d.) still supports the "person with Down syndrome" terminology.

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[SKEPTICAL INQUIREE BENJAMIN RADFORD

Benjamin Radford is a research fellow at the Committee for Skeptical Inquiry and author or coauthor of several books, including *Investigating Ghosts: The Scientific Search for Spirits*.

Fatima Miracle Claims All Wet

Q: **I read your investigation of the Miracle of Fatima and the last appearance of the Virgin. I noticed you dismissed the event based on the perception of the people as some mass delusion. Are you aware that it had been raining all night and into the day? Everyone present was soaked—as was the soil—but after the vision, the soil was dry. How do you explain that?**

—G. Peacock

A: The story of a famous miracle in Fatima, Portugal, began in May 1917, when three children claimed to have encountered the Virgin Mary on their way home from tending a flock of sheep. The oldest girl, Lucia, was the only one to speak to her, and Mary told the children that she would reappear to them on the thirteenth day of each of the next six months. She then vanished. The children soon told their parents, and while some in the village didn't believe their tale, others did—and told more people. As the weeks and months passed, more and more of the faithful made pilgrimages to Fatima, where the children claimed to receive Mary's visits. Still no one else saw the Virgin Mary; instead, the gathered adults would stand riveted as Lucia described her visions.

It was Mary's final appearance, on October 13, 1917, that became the most famous. In his book *Looking for a Miracle*, Joe Nickell states:

> An estimated 70,000 people were in attendance at the site, anticipating the Virgin's final visit and with many fully expecting that she would work a great miracle. As before, the figure appeared, and again only to the children. Identifying herself as "the Lady of the Rosary," she urged repentance and the building of a chapel at the site. After predicting an end to [World War I] and giv-

While there were certainly strong elements of mass suggestion at the event, it's not quite accurate to call it a "mass delusion."

ing the children certain undisclosed visions, the lady lifted her hands to the sky. Thereupon Lucia exclaimed, "The sun!" As everyone gazed upward, and saw that a silvery disc had emerged from behind clouds, they experienced what is known [as] a "sun miracle." (Nickell 1993)

As Ray Hyman has cautioned, before attempting to explain some strange event we should first be sure there is something to explain.

Some present claimed they saw the sun dance around the heavens; others said the sun zoomed toward Earth in a zigzag motion. Some people reported seeing brilliant colors spin out of the sun in a psychedelic, pinwheel pattern; still thousands of others saw nothing unusual at all. The whole event took about ten minutes, and this Miracle of the Sun, as it became known, is one of the best-known events at Fatima.

O MILAGRE DE FÁTIMA

Varios aspectos do povo ajoelhado e orando no momento de deslumbrar o sol e de se dar o fenomeno que tanto impressionou a multidão.

no vegalhão colossal d'aquele posto que ali se juntou a 13 de outubro. O teu racionalismo sofreu um firme choque e quer-a estabelecer uma opinião segura socorrendo-te do depoimento dos spetros com que o meu, pois que estou lá apenas no desempenho de uma missão bem difícil, tal a de relatar imparcia mente para um grande diario, *O Seculo*, os factos que diante de mim se desenrolassem e tudo quanto de curioso e de edificativo a eles se prendesse. Não ficará por satisfazer o teu desejo, mas decerto que os nossos olhos e os nossos ouvidos não viram nem ouviram coisas diversas, e que raros foram os que ficaram insensiveis á grandeza de semelhante espectaculo, unico entre nós e de todo o ponto digno de meditação e de estudo ..

(Carta a alguem que pede um testemunho insuspeito).

Quebrando um silencio de mais de vinte anos e com a invocação dos longinquos e saudosos tempos em que convivemos n'uma fraternal camaradagem, illuminada então pela fé comum e fortalecida por identicos propositos, escreves-me para que te diga, sincera e minuciosamente, o que vi e ouvi na chamada da Fátima, quando a turba de celestes anarições congregou n'aquele desolado ermo dezenas de milhares de pessoas mais sedentas, segundo creio, de sobrenatural do que impedidas por mera curiosidade ou necessas de um logro... Estão os catolicos em desacordo sobre a importancia e o significação do que presenciaram. Uns convenceram-se de que se finham cumprido prometimentos do Alto, outros acham-se ainda longe de acreditar na incontroversa realidade de um milagre. Foste um crente na tua juvenitude e deixaste de sel-o. Pessoas de familia arrastaram-te a Fátima,

O que ouviu e me leyou a Fátima? Que a Virgem Maria, depois da festa da Ascenção, appareceu a tres crianças que apascentavam gado, duns mocinhos e um zagalete, recomendando-lhes que orassem e prometendo-lhes apparecer ali, sobre uma azinheira, no dia 13 de cada mez, até que em outubro lhes diria qualquer signal do poder de Deus e faria revelações. Espalhou-se a nova por muitas leguas em redondo; veiu, de terra em terra, até os confins de Portugal, e a roma-

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The writer had a few misunderstandings about what I'd written, including that I had described (or dismissed) the event as a "mass delusion." I'm not quite sure what that is. Usually a delusion occurs in a single person, but some phenomena, such as *folie à deux*, might be considered an example of a mass delusion (see Joe Nickell's column in this issue). There's mass hysteria—more correctly known as mass sociogenic illness—which is a topic that Robert Bartholomew and I have written several books about. But I never claimed that the Fatima sighting was mass hysteria *per se*; instead, some aspects of it, such as the sun being said to move about the sky, were suggestive. Mass hysteria often manifests in mild but verifiable physical symptoms, such as headaches, fainting, and nausea. While there were certainly strong elements of mass suggestion at the event, it's not quite accurate to call it a "mass delusion." In any event, though the sun shifting was the marquee miracle at Fatima, there were a few ancillary miracles, including the one mentioned by the writer: that the crowds and land were drenched before the miracle and dry mere minutes later.

The Evaporation Explanation

As with any investigation, we can begin by verifying the assumptions underlying the claim. The key question is about an apparent moisture miracle: If the skies had opened up and it "had been raining all night and into the day" resulting in soaked crowds and soil, then how was it possible that everything was dry when the solar display ended?

Evaporation is an obvious explanation—and depends on many factors, including ambient humidity, temperature, and even the color of wet cloth—but surely so much water could not have simply vanished in so short a time. We may begin examining this apparent miracle by questioning its assumptions. As Ray Hyman has cautioned, before attempting to explain some strange event we should first be sure there is something to explain.

There is clear evidence that it had been raining before the miracle, though not necessarily "all night and into the day." A more relevant question is what the conditions were shortly before the event; accounts conflict, and it's not clear precisely what the weather was at the time of the miracle itself. In his book *Entities*, Joe Nickell refers variously to "a stormy and rainy October 13" and the sun being "seen through thin clouds" (Nickell 1995). Of course, whatever cloud cover there was could not have been heavy since the famed Miracle of the Sun would not have been seen at all.

In Portugal, most of the rain falls in winter, from November to March. This does not preclude the possibility of a continual rainfall in mid-October, of course, but it does demonstrate that the rainy season typically begins later in the year.

The burden of proof is on those claiming that something unusual happened that day, and in this case, it falls far short.

Though accounts differ, for corroboration we can examine photographs of the event and just before, which do not show heavy rain—or any rain at all in fact. The clothing in those visible does not appear to be soaked, and fabric does not cling to skin or hang as though saturated. The lack of open umbrellas in the photographs taken *at the time* of the miracle is notable; the few that can be seen appear to be shielding their users from bright *sunlight*, not torrential rain. There are also few if any visible puddles or streams that might be expected after eighteen or so hours of rainfall.

A few photographs exist from the morning *before* the miracle when it was in fact raining, and a sea of dark umbrellas can be seen. This would of course suggest that those present, at least those under umbrellas, were largely spared from whatever rains or drizzle there was (if those with umbrellas were somehow

just as wet as those without, that would be an especially curious "miracle").

At this remove, it's not possible to conclusively demonstrate how much rain fell, precisely when and where, and how wet any pilgrims' clothes may have been before and after the miracle. No one carefully measured and compared the water content of clothes or soil before and after the miracle. In any event, the measurement is somewhat subjective; a faithful pilgrim might well mistakenly deem her damp dress or blouse to instead be "perfectly dry," especially in the wake of a profound religious experience. The burden of proof is on those claiming that something unusual happened that day, and in this case, it falls far short.

Most of those present did not report the drying miracle, and what sporadic stories there are seem to have arisen afterward in classic folkloric fashion. There is in fact a Catholic legend tradition of miracle waters that dry almost instantly—including those at the Lourdes shrine in France, where Mary had also been said to have appeared some sixty years earlier. In an article for *America*, James Martin describes his visit to Lourdes:

> From the other side of another curtain I hear the splashing of someone entering the bath, and in a few seconds he emerges with a wide grin. As I wonder if the legend that Lourdes water dries off miraculously is true, another curtain parts ... . And, yes, the water dries from my skin immediately. (Martin 2004)

For the devout at Fatima who may have noticed (or suspected) that their clothes were (or might have been) drier than they would have otherwise expected, they had a ready-made precedent template for the miracle.

No one is suggesting that the area was bone dry, of course. The photographs (such as they are for being a century old and poorly exposed) do seem to show overcast skies, and it's perfectly plausible that there had been a light rain that morning. But that's a far cry from the claim that the pilgrims and land were "soaked," and this discrepancy could easily account for why people's clothes were—or seemed to be—dryer than they might have expected. ■

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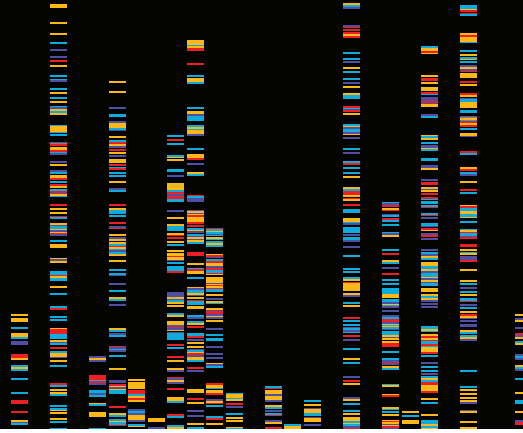
CSICON 2018 SPECIAL SECTION

Seven Big Misconceptions about Heredity



Many people have misconceptions about heredity—how we are connected to our ancestors and how our inheritance from them shapes us. Rather than dispelling those misconceptions, our growing fascination with testing our DNA may only intensify them.

CARL ZIMMER

If someone says, "I guess it's in my DNA," you never hear people say, "DN—*what*?" We all know what DNA is, or at least think we do.

It's been seven decades since scientists demonstrated that DNA is the molecule of heredity. Since then, a steady stream of books, news programs, and episodes of *CSI* have made us comfortable with the notion that each of our cells contains three billion base pairs of DNA, which we inherited from our parents. But we've gotten comfortable without actually knowing much at all about our own genomes.

Indeed, if you had asked to look at your own genome twenty years ago, the question would have been absurd. It would have been as ridiculous as asking to go to the moon. When scientists unveiled the first rough draft of the human genome in the early 2000s, the final bill came to an Apollo-scale $2.7 billion.

Since then, advances in DNA sequencing and software for analyzing genetic data have steadily brought down the price tag. By 2006, it cost only $14 million to sequence a single human genome. Even at that drastically reduced price, though, only a few big labs with major financial support would dare take on such an expensive project. But in the years that followed, DNA sequencing continued its exponential cost crash, becoming cheap enough to turn into a consumer product.

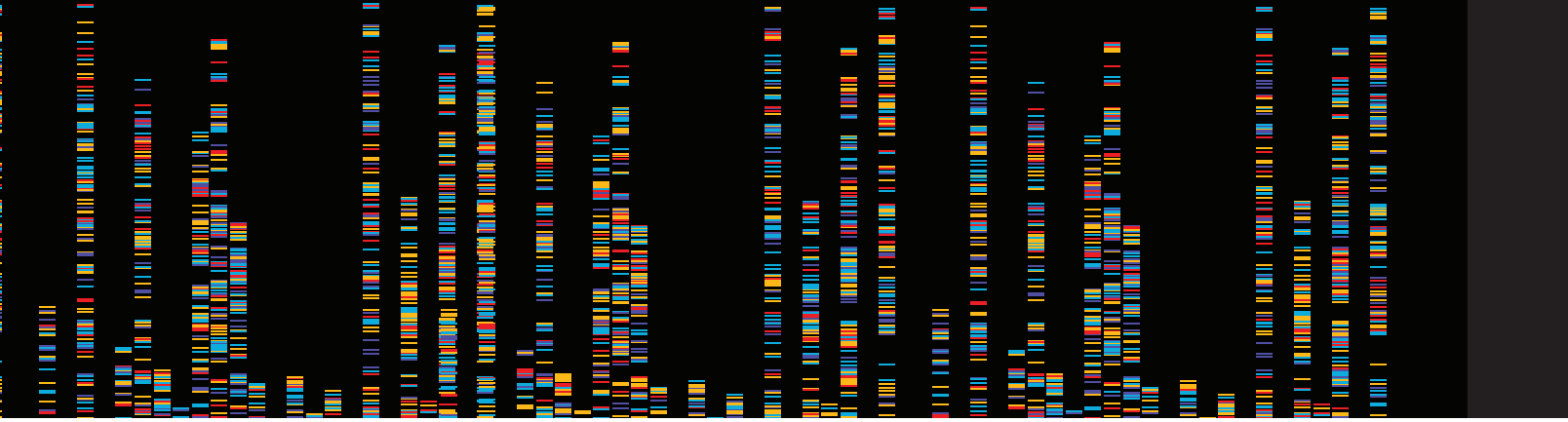
If you want to get your entire genome sequenced—all three billion base pairs in your DNA—a company called Dante Labs will do it for $699. You don't need whole genome sequencing to learn a lot about your genes, however. The 20,000 genes that encode our proteins make up less than 2 percent of the human genome. That fraction of the genome—the "exome"—can be yours for just a few hundred dollars. The cheapest insights come from "genotyping"—in which scientists survey around a million spots in the genome known to vary a lot among people. Genotyping—offered by companies such as 23andMe and Ancestry—is typically available for under a hundred dollars.

Thanks to these falling prices, the number of people who are getting a glimpse at their own genes is skyrocketing. By 2019, over twenty-five million worldwide had gotten genotyped or had their DNA sequenced. At its current pace, the total may reach 100 million by 2020.

Future generations will look back at today as a pivotal moment in DNA's cultural history. People are no longer thinking of their DNA as a black box but as a database to be mined. They're learning that they have inherited mutations that raise their risk of certain diseases. They're getting estimates of their ancestry based on genetic markers that are common in certain parts of the world. They're merging their genetic information with genealogy to discover distant relatives. Some are also discovering some not-so-distant relatives that until now were family secrets.

There's a lot we can learn about ourselves in these test results. But there's also a huge opportunity to draw the wrong lessons.

Many people have misconceptions about heredity—how we are connected to our ancestors and how our inheritance from them shapes us. Rather than dispelling those misconceptions, our growing fascination with our DNA may only intensify them. A number of scientists have warned of a new threat they call "genetic astrology." It's vitally important to fight these misconceptions about heredity, just as we must fight misconceptions about other fields of science, such as global warming, vaccines, and evolution. Here are just a few examples.



Future generations will look back at today as a pivotal moment in our cultural history. People are no longer thinking of their DNA as a black box but as a database to be mined.

Misconception | 1
Finding a Special Ancestor Makes You Special

There are certain clubs to which ancestry is the key to admission. You can get into the Mayflower Society if you descend from the passengers of that famous ship. You can join the Order of the Crown of Charlemagne if you can prove that the Holy Roman Emperor is your ancestor. It's a thrill to discover we have a genealogical link to someone famous—perhaps because that link seems to make us special, too.

But that's an illusion. I could join the Mayflower Society, for example, because I'm descended from a servant aboard the ship named John Howland. Howland's one claim to fame is that he fell out of the *Mayflower*. Fortunately for me, he got fished out of the water and reached Massachusetts. But I'm not the only fortunate one; by one estimate, there are two million people who descend from him alone.

Mathematicians have analyzed the structure of family trees, and they've found that the further back in time you go, the more descendants people had. (This is only true of people who have any living descendants at all, it should be noted.) This finding has an astonishing implication. Since we know Charlemagne has living descendants (thank you, Order of the Crown!), he is likely the ancestor of every living person of European descent. And if you could get in a time machine and travel back a few thousand years, you could find someone who was a common ancestor of all living people on Earth.

Misconception | 2
You Are Connected to All Your Ancestors by DNA

When you look at your family tree, you're looking at a series of branching lines that link you to your ancestors. What exactly flows down through those lines as they travel through time? A few centuries ago, people might say it was blood. In recent decades, blood has been replaced in our popular imagination with DNA. After all, our genes didn't come out of nowhere. We inherited them.

But genetics do not equal genealogy. It turns out that practically none of the Europeans who descend from Charlemagne inherited any of his DNA. All humans, in fact, have no genetic link to most of their direct ancestors.

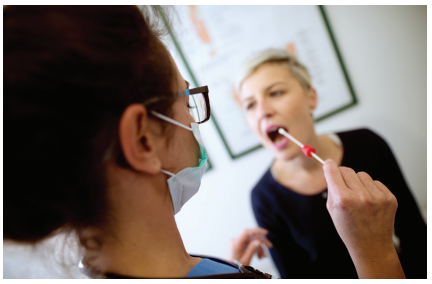
The reason for this disconnect is the way that DNA gets passed down from one generation to the next. Every egg or sperm randomly ends up with one copy of each chromosome, coming either from a person's mother or father. As a result, we inherit about a quarter of our DNA from each grandparent—but only on average. Any one person may inherit extra DNA from one grandparent and less from another. If you go back to the next generation, you'll find that each great-grandparent contributed approximately an eighth of your DNA—but, again, that's only an average. Some of them may have contributed much more, others much less.

If you go back a few generations more, that contribution can drop all the way to zero. Graham Coop, a geneticist at the University of California, Davis, and his colleagues have calculated the odds of sharing no DNA with an ancestor as they moved back through the generations. If you go back ten generations, the odds of having DNA from any given ancestor drop to less than 50 percent. They go down even more as you push back further through your ancestry. While it is true that you inherit your DNA from your ancestors, that DNA is only a tiny sampling of the genes in your family tree.

Even without a genetic link, though, your ancestors remain your ancestors. They did indeed help shape who you are—not by giving you a gene for some particular trait, but by raising their own children, who then raised their own children in turn, passing down a cultural inheritance along with a genetic one.

Misconception | 3
Ancestry Tests Are as Reliable as Medical Tests

Millions of people are getting ancestry reports based on their DNA. My own report informs me that I'm 43 percent Ashkenazi Jewish, 25 percent Northwestern European, 23 percent South/Central European, 6 percent Southwestern European, and 2.2 percent North Slavic. Those percentages sound impressive, even definitive. It's easy to conclude that ancestry reports are as reliable as stepping on a scale at the doctor's office to get your height and weight measured.



That is a mistake, and one that can cause a lot of heartbreak. To estimate ancestry, researchers compare each customer to a database of thousands of people from around the world. Those "reference populations" are typically selected because they have deep roots where they live. Some researchers select only people whose family has lived in the same place for three generations, for example. In each population, there are some genetic variants that are unusually common and others that are unusually rare. Researchers then look for these variants in a customer's DNA. They can identify stretches of DNA that are likely to have originated in a particular part of the world. While some matches are clear-cut, others are less so. As a result, ancestry estimates always have margins of error—which often go missing in the reports customers get.

To gain more certainty in their estimates, scientists are building up bigger databases. In 2018, Ancestry.com unveiled a new set of estimates for its customers. They got a lot of backlash. People who had initially been thrilled to discover a small portion of their ancestry came from Italy or Cameroon were devastated to now learn that they had no such link at all.

These estimates are going to get better with time, but there's a fundamental limit to what they can tell us about our ancestry. To say I am 43 percent Ashkenazi doesn't have the same timeless truth as saying I'm 43 percent carbon. Carbon has been carbon for billions of years. But the Ashkenazi people emerged through history. In the Roman Empire, people of Near East and European ancestries came together and started having children. In the Middle Age, Jews in northern and eastern Europe began to be persecuted and formed increasingly isolated communities. In these small groups, children increasingly inherited the same set of genetic variants. From an estimated population of just 350 ancestors, the Ashkenazi population has now reached ten million. They all share a number of distinctive genetic markers from that period of history. But their history reaches farther back in time, to older peoples.

While it is true that you inherit your DNA from your ancestors, that DNA is only a tiny sampling of the genes in your family tree.

It's easy to conclude that ancestry reports are as reliable as stepping on a scale at the doctor's office to get your height and weight measured. That is a mistake, and one that can cause a lot of heartbreak.

Researchers are getting glimpses of those older peoples by retrieving DNA from ancient skeletons. And they're finding that our genetic history is far more tumultuous than previously thought. Time and again, researchers find that the people who have lived in a given place in recent centuries have little genetic connection to the people who lived there thousands of years ago. All over the world, populations have expanded and migrated, coming into contact with other populations. In Europe, for example, new waves of genetically distinct people have arrived from elsewhere every few thousand years, either replacing or interbreeding with the people who lived there before. Today, Europeans are genetically similar to each other, but only because the genes of their disparate ancestors—from places such as Africa, Turkey, and Russia—have been well mixed. If you want to find purity in your ancestry, you're on a fool's errand.

Misconception | 4
There's a Gene for Every Trait You Inherit

When we learn about genetics in school, we learn about Gregor Mendel. In the 1850s, Mendel crossed lines of pea plants and discovered that their traits—such as the color of their flowers or the texture of their peas—were carried by invisible hereditary factors. Some factors were dominant, meaning that inheriting just one copy of them determined a trait. Other factors were recessive, meaning that they could shape a pea plant if it inherited two copies.

Mendel is a great place to start learning about heredity but a bad place to stop. There are some traits that are determined by a single gene. Whether Mendel's peas were smooth or wrinkled was determined by a gene called SBEI. Whether people develop sickle cell anemia or not comes down to a single gene called HBB. But many traits do not follow this so-called Mendelian pattern—even ones that we may have been told in school are Mendelian.

Consider your ear lobes. For decades, teachers taught that they could either hang free or be attached to the side of our heads. The sort of ear lobes you had was a Mendelian trait, determined by a single gene. In fact, our ear lobes typically fall somewhere between the two extremes of strongly attached to fully free. In 2017, a team of researchers compared the ear lobes of over 74,000 people to their DNA. They looked for genetic variants that were common in people at either end of the ear-lobe spectrum. They pinpointed forty-nine genes that appear to play a role in determining how attached they are to our heads. There well may be more waiting to be discovered.

None of those forty-nine genes is a gene "for" ear-lobe attachment. That language just doesn't make sense for the way most genes work. The genes that the scientists identified become active in many cells in an embryo. Some are active in skin cells across the body. Some are active in hair and sweat glands as well. Some help build the intricate anatomy of the inner ear. The attachment of our ear lobes is the result of a symphony performed by these players.

The genetics of ear lobes is actually very simple compared to other traits. Studying height, for example, scientists have identified thousands of genetic variants that appear to play a role. The same holds true for our risk of developing diabetes, heart disease, and other common disorders. We can't expect to find a single gene in our DNA tests that determines whether we'll die of a heart attack. Nor should we expect easy fixes for such complex diseases by repairing single genes.

Misconception | 5
The Genes You Inherit Explain Exactly Who You Are

Throughout our lives—through our successes and failures, through our joys and suffering—we often wonder how things turned out the way they did. The more that scientists explore our DNA, the easier it is to shrug and say that it was all programmed in our genes.

Take, for example, a recent study on how long people stay in school. Researchers examined DNA from 1.1 million people and found over 1,200 genetic variants that were unusually common either in people who left school early or in people who went on to college or graduate school. They then used the genetic differences in their subjects to come up with a predictive score, which they then tried out on another group of subjects. They found that in the highest-scoring 20 percent of these subjects, 57 percent finished college. In the lowest-scoring 20 percent, only 12 percent did.

But these results don't mean that how long you stayed in school was determined before birth by your genes. Getting your children's DNA tested won't tell you if you should save up money for college tuition or not. Plenty of people in the educational attainment study who got high genetic scores dropped out of high school. Plenty of people who got low scores went on to get PhDs. And many more got an average amount of education in between those extremes. For any individual, these genetic scores make predictions that are barely better than guessing at random.

This confusing state of affairs is the result of how genes and the environment interact. Scientists call a trait such as how long people stay in school "moderately heritable." In other words, a modest amount of the variation in education attainment is due to genetic variation. Lots of other factors also matter, too—the neighborhoods where people live, the quality of their schools, the stability of their family life, their income, and so on. What's more, a gene that may have an influence on how long people stay in school in one environment may have no influence at all in another.

Misconception | 6
You Have One Genome

In 2002, a woman named Lydia Fairchild applied for enforcement of child support when she separated from the father of her two children. The state of Washington required genetic testing to confirm his paternity. The tests showed he was indeed the father. But they also showed that Fairchild was not the mother.

State officials threatened to charge Fairchild with fraud, despite her protests that she had given birth to the children and the testimony of her mother, who had seen the birth of her grandchildren. When Fairchild went into a hospital to give birth to another child, a court official came to witness the delivery and watch the nurses draw blood for another DNA test. Once more, the test indicated that Fairchild was not the infant's mother.

This absurd situation arose because of the common assumption that each of us carries a single genome. According to this assumption, you will find an identical sequence of DNA in any cell you examine. But there are many ways in which we can end up with different genomes within our bodies.

Fairchild is known as a chimera. She developed inside her mother alongside a fraternal twin. That twin embryo died in the womb, but not before exchanging cells with Fairchild. Now her body was made up of two populations of cells, each of which multiplied and developed into different tissues. In Fairchild's case, her blood arose from one population, while her eggs arose from another.

Women can also become chimeras with their own children. During pregnancy, fetuses can shed cells that then circulate throughout a woman's body. In some cases they linger on after birth. They can then develop into muscle, breast tissue, and even neurons.

It's unclear how many people are chimeras. Once they were considered bizarre rarities. Scientists became aware of them only in cases such as Lydia Fairchild's, when their mixed identity made itself known. In recent years, researchers have been carrying out small-scale surveys that suggest that perhaps a few percent of twins are chimeras, but

Women can become chimeras with their own children. During pregnancy, fetuses can shed cells that then circulate throughout a woman's body. They can then develop into muscle, breast tissue, and even neurons.

Genes involved in making enamel need to be switched on in developing teeth. But you wouldn't want your skin cells to make it too, trapping you in an enamel sarcophagus.

the true number could be higher. As for chimeric mothers, they may be the rule rather than the exception. In a 2017 study, researchers studied brain tumors taken from women who had sons. Eighty percent of them had Y-chromosome-bearing cells in their tumors.

Chimerism is not the only way we can end up with different genomes. Every time a cell in our body divides, there's a tiny chance that one of the daughter cells may gain a mutation. At first, these new aberrations—called somatic mutations—seemed important only for cancer. But that view has changed as new genome-sequencing technologies have made it possible for scientists to study somatic mutations in many healthy tissues. It now turns out that every person's body is a mosaic, made up of populations of cells with many different mutations.

Misconception | 7
Genes Don't Matter Because of Epigenetics

The notion that our genes are our destiny can trigger an equally false backlash: that genes don't matter at all. And very often, those who push against the importance of genetics invoke a younger, more tantalizing field of research: epigenetics.

Ask five scientists to define *epigenetics* and you may get five different definitions. But they will all center on the fact that genes, on their own, do nothing. They simply store information that our cells can use as guides for building proteins or RNA molecules. But our cells only use genes in response to certain combinations of signals. It can be disastrous to use genes at the wrong time or in the wrong place. Genes involved in making enamel need to be switched on in developing teeth. But you wouldn't want your skin cells to make it too, trapping you in an enamel sarcophagus.

Our cells use many layers of control to make proper use of their genes. They can quickly turn some genes on and off in response to quick changes in their environment. But they can also silence genes for life. Women, for example, have two copies of the X chromosome, but in early development, each of their cells produces a swarm of RNA molecules and proteins that clamp down on one copy. The cell then only uses the other X chromosome. And if the cell divides, its daughter cells will silence the same copy again.

One of the most tantalizing possibilities scientists are now exploring is whether certain epigenetic "marks" can be inherited not just by daughter cells but by daughters—and sons. If people experience trauma in their lives and it leaves an epigenetic mark on their genes, for example, can they pass down those marks to future generations?

If you're a plant, the answer is definitely yes. Plants that endure droughts or attacks by insects can reprogram their seeds, and these epigenetic changes can get carried down several generations. The evidence from animals is, for now, still a mixed bag. In one intriguing experiment, researchers separated male mouse pups from their mothers from time to time, causing them stress. Later, they used sperm from those stressed mice to fertilize eggs, and some of their descendants proved to be unusually sensitive to stress. But skeptics have questioned how epigenetics can transmit these traits through the generations, suggesting that the results are just statistical flukes. That hasn't stopped a cottage industry of epigenetic self-help from springing up. You can join epigenetic yoga classes to rewrite your epigenetic marks or go to epigenetic psychotherapy sessions to overcome the epigenetic legacy you inherited from your grandparents.

You may feel more limber after your yoga class. And you may feel better after having talked about your anxiety. But your genes will still work much the same as they did before. ■

Carl Zimmer is an award-winning science writer and the author, most recently, of *She Has Her Mother's Laugh: The Powers, Perversions, and Potential of Heredity* (selected by *The Guardian* as the best science book of 2018). He writes the "Matter" column for *The New York Times*. His earlier books include *Evolution: Triumph of an Idea* (companion to the PBS Series), *The Tangled Bank: An Introduction to Evolution*, and *Microcosm: E. Coli and the New Science of Life*. He spoke at CSICon 2018.

Rossi's E-Cat: Exposé of a Claimed Cold Fusion Device

Andrea Rossi's E-Cat "fusion" device has attracted large investments. This investigation by the Australian Skeptics' chief investigator critiques the claims—including endorsements from some scientists—and reveals the likely deception used to make investors think it works.

IAN BRYCE

Editor's note: Physicist Sadri Hassani's Skeptical Inquirer *article "Why E-Cat Is a Hoax" (Hassani 2019) explained how Andrea Rossi's claims about his E-Cat (energy catalyzer) device are at variance with well-established laws of physics. But occasionally new observations might suggest modifications to those laws (see three-legged stool test at end). This is especially critical when there is apparent verification of the measurements by independent scientists. This shows the importance of scrutiny by skeptical investigators. In this article, Ian Bryce relates the results of his five-year investigation.*

Introduction

The E-Cat (energy catalysis) apparatus is claimed to produce power through nuclear fusion, yet the operators somehow walk around it without any radiation effects. Fusion occurs in the center of the sun, other stars, and a hydrogen bomb, yet this device operates on a bench at room temperature. If it worked as claimed, it would require the rewriting of most physics textbooks. The inventor hopes for a Nobel Prize but lacks any science qualifications and has been incarcerated several times for previous energy schemes that were found not to work. Earlier cold fusion claims reported twenty-six milliwatts of power, but this one claims one megawatt. The evidence strongly suggests that the inventor was smuggling power in past the metering through a retasked earth lead.

On January 31, 2019, Rossi's company issued a video demonstration and claimed the devices were now ready for the market (see sidebar "Rossi's Latest Reactor 'Revealed' in January Video," p. 47).

Who could possibly fall for this claim? Many respected nuclear scientists from around the world it seems, some involved in awarding Nobel Prizes. Not only leading skeptics but some NASA officials and investors who poured in tens of millions of dollars (and still are) and promised hundreds of millions more have fallen for it. This has wasted money, time, and effort that could instead have been directed toward real improvements in energy production, with benefits for the planet's ecosystem and human welfare.

This article traces the history of Andrea Rossi's E-Cat and the officials who should know better but fell for it. It outlines the efforts of Australian Skeptics and philanthropist Dick Smith to expose the episode and reports on new developments. (Smith has long championed and supported skeptical investigations of extraordinary claims; Australia has designated him a "National Living Treasure" [Frazier 2015].)

Rossi's Background

Andrea Rossi obtained a master's degree in philosophy from the University of Milan in 1973. He also claimed an engineering degree from the University of Kensington in California, but this was exposed as a diploma mill. Rossi was (and is) an enthusiastic and accomplished long-distance runner. Through working in family businesses, the young Rossi became adept at building industrial plants. He traveled frequently, especially to Sweden and the United States. He now lives and works in Florida.

Rossi's first major project was called Petroldragon. This was a plant intended to convert industrial waste into useable fuel oil. Despite large investments, it's not clear if it ever worked. Rossi's large stocks of waste (60,000 tons), including toxic liquids and rubber tires, burdened him with exorbitant disposal obligations he was unable to meet, for which he was prosecuted and spent six months in jail in 1995.

Rossi's next project was a thermoelectric generator, intended to convert low-grade waste heat, such as from engine exhausts, into electricity. This is a known technology of very low efficiency, around 2 percent, but Rossi claimed to have achieved 20 percent.

He installed them in various diesel generators he was making and selling in Italy as a background business of Leonardo Corporation. In the United States, the device was promoted by his Leonardo Technologies Inc. (LTI). Twenty-seven units were tested by the U.S. Department of Defense (DoD), but none worked as claimed (Rossi 2019; U.S. Army Corps of Engineers 2004).

Meanwhile, Rossi was being prosecuted in Italy for many other matters, including bankruptcy, accounting fraud, money laundering, and dumping toxic waste. Some charges were dropped, on some he was acquitted, and on others he was fined. He spent a year in jail in Italy again from 2000–2001 (Lewan 2014, 31). Rossi had heard of the 1989 Fleischmann and Pons claims of cold fusion. Cold fusion is now more frequently called Low Energy Nuclear Reactions (LENR). In anticipation of its thirtieth anniversary this spring, cold fusion was recently described and recounted in these pages (Ball 2019). Rossi used his time in jail to study this topic and decided this would be his next project.

I call upon all these scientists to reexamine the evidence and to retract their statements supporting E-Cat. Hopefully this will put an end to the charade.

Development of E-Cat

Following his release in June 2001, Rossi built some reactors and soon claimed to have generated "hundreds of watts." In 2009, he reported holding successful demonstrations for various parties, including the Italian energy producer Enel, the U.S. Department of Energy (DoE), and the U.S Department of Defense (DoD) (further details of these and other tests and demonstrations is given in supporting documentation online).

Defkalion

Of more significance was a demonstration in October 2010 in Bologna for a group of eminent Greeks, including Christos Stremenos, a retired professor of physical chemistry and Greek ambassador in Italy. No results are available for this demonstration, but they must have been impressive because the group went on to form an alliance called Defkalion. They became deeply entangled with Rossi before splitting amid acrimony and hundred-million-euro lawsuits—more on this later.

Rossi had his marketing machine in gear by then and held a rapid series of demonstrations. These included one in December 2010 for a team of scientists, in January 2011 for the press, and on March 29 of that same year for some Swedish scientists. This was

Figure 1: Some in the LENR community believe that chickens can transmute elements.

Figure 2: (L-R) Rossi demonstrates E-CAT to Swedish scientists Kullander and Essén on March 29, 2011.

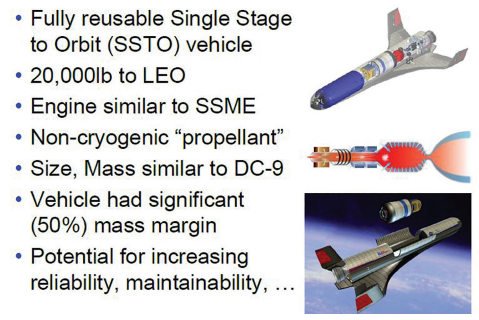

• Fully reusable Single Stage to Orbit (SSTO) vehicle
• 20,000lb to LEO
• Engine similar to SSME
• Non-cryogenic "propellant"
• Size, Mass similar to DC-9
• Vehicle had significant (50%) mass margin
• Potential for increasing reliability, maintainability, …

Figure 3: NASA's concept of an LENR-powered spaceplane in a presentation by Zawodny.

followed by a test in April for Italian TV and technology journalist Mats Lewan. There were more tests in May, June, September, and October 2011. The invited observers gave generally glowing reports.

These were all with one type of device and with similar results. I am going to focus on the March 29, 2011, test, which was the best documented and the one I exposed. But first let me introduce the main players.

Mats Lewan

Mats Lewan was a writer for Swedish technology magazine *Ny Teknik.* He was immediately convinced by Rossi and became his most loyal supporter. He readily and unquestioningly published Rossi's claims in *Ny Technik* and on his own website. Possessing electrical knowledge, he attended tests in 2011 and photographed and filmed several of Rossi's demonstrations. He introduced several relevant parties to Rossi. His book *An Impossible Invention* (Lewan 2014) reads like a Rossi love letter but contains useful detail on events.

Lewan's gullibility toward claims of scammers and the deluded has no limits (Lewan 2014, 31). He presents as evidence for cold fusion reports from several "scientists" of biological transmutation. Chickens, when starved of calcium, are claimed to transmute the element potassium into calcium to make their egg shells!

Swedish Scientists Essén and Kullander

Hano Essén is a Swedish theoretical physicist at the Royal Institute of Technology in Stockholm. He has been a president of the Swedish Skeptics Society—sister of Australian Skeptics Inc (ASI) and of the Center for Inquiry (CFI). Essén had read Rossi's reports and commented favorably.

Sven Kullander (d. 2014) was an experienced nuclear physicist and published some ideas of his own on cold fusion. He was chairman of the Energy Committee of the Swedish Royal Academy of Sciences, which is involved in awarding Nobel Prizes.

As professors of nuclear physics, these two were invited by Rossi (via Lewan) to view an E-Cat demonstration on March 29, 2011. Given the backgrounds of both Rossi and his claims, one wonders why they became involved at all.

They observed carefully and critically and provided a detailed report (Kullander and Essén 2011). They could see no hidden pipes or wires that could explain the ongoing energy production. This was widely published, along with media statements including: "My belief [was] probably … strengthened considerably when I saw and measured how it all works, that there is an energy release far beyond what one might expect."

This authoritative endorsement soon had the blogosphere buzzing with expectations of solving the world's energy problems. Rossi started offering franchises for licensing around the world. Investors were queuing at Rossi's doorstep.

Authoritative endorsements of E-Cat soon had the blogosphere buzzing with expectations of solving the world's energy problems.

Swedish Reference Group

The Swedish scientists were so impressed by Rossi's demonstrations that they persuaded other authorities back in Sweden. To properly evaluate the measurements and to investigate the theory, they set up an informal reference group at a meeting in Sweden on July 4, 2011 (Lewan 2014, 132). This also included other scientific authorities Lars Tegnér, Bo Höistad, and Roland Pettersson, all from Uppsala University in Sweden, and professor of physics Hidetsugu Ikegami of Osaka University in Japan. It seems they were blind to the fact that scientists can be fooled.

There was also an Italian physicist, the late Sergio Focardi, who supported Rossi by maintaining a blog appearing to be on the physics of LENR. This involved Widom-Larson theory but never achieved any credibility.

In contrast, there was at least one authority who was skeptical of Rossi's claims from the start. Swedish physicist Peter Ekström published an article titled "Cold Fusion Once More Becomes Only Hot Air" in May 2011 in *Fysikaktuellt* (*Physics News*). He described Lewan as "like an embedded journalist—easily led by his hosts."

Ekström pointed out to me that all properly observed nuclear reactions produce ionizing radiation and daughter isotopes, which (at power production levels) should cause death in seconds. Yet in all demonstrations, Rossi, his assistants, and his audience have always walked freely around the equipment with no sign of dropping dead. Attendees at key demonstrations are named in a longer list of tests (Bryce 2019a).

Australian Skeptics investigation

One would-be investor was Sol Millin, a retired technician in the hippie center Byron Bay. In December 2011, he approached Australian entrepreneur and philanthropist Dick Smith with a "highly lucrative trillion-dollar market opportunity." Would Smith provide the AU$200,000 needed for the Australian license?

Smith replied "… If I invented such an incredible machine, I would make sure I would get a simple report from someone who is quite independent to say that it actually works. Can you send me a copy of this and I will send off the cheque?" So it was with some surprise that Smith soon received the glowing report by the two Swedish nuclear physicists. It concludes, "Any chemical process for producing 25 kWh [total energy over six hours, not power] from any fuel in a 50 cm^3 container can be ruled out. The only alternative explanation is that there is some kind of a nuclear process that gives rise to the measured energy production."

Smith approached the Australian Skeptics, which he helped found in 1980 and of which he is still a patron and supporter. Thus, the matter came to my desk (I have been chief investigator since its founding). I attended an investors meeting held by Millin—the Byron Bay connection is a saga in its own right, as reported in Australian *Skeptic* magazine (Bryce 2012). I also communicated with Rossi and wrote to the scientists.

Figure 4: Monitoring of the input power—does not include the earth lead.

My research uncovered at least seventeen scientists and engineers who had either witnessed a test or analyzed the results and gave some support for Rossi's device called E-Cat (Energy Catalyzer) or for Low Energy Nuclear Reactions (LENR) in general (Bryce 2019b). Brian Josephson, Nobel laureate for his Josephson Junction quantum transistor, consistently supported Rossi's claims in an interview. (Josephson has also long been criticized by colleagues and scientific skeptics for supporting mysticism, ESP, and remote viewing.)

Certain senior NASA scientists attended various presentations and demonstrations by Rossi and later gave glowing internal reports (Zawodny 2011; Bushnell 2011; Nelson 2011). They gave strong praise to LENR in general: "Over 2 decades with over 100 experiments worldwide indicate LENR is real, much greater than Chemical … ." And specif-

The Australian Connection

Rossi's ability to sell E-Cat licenses around the world, and in some countries reportedly twice, are well known. However, my personal connections mean that much is known about the Australian side. Both would-be license holders have been open in discussing their experiences and in sharing their documentation, for which I thank them.

As described in the main article, the first prospective licensee was Solihin Millin, from the hippy center of Australia, who signs his emails "love and peace." His venture Byron New Energy includes a raft of technologies including "gravity, anti-gravity, electromagnetic, electronic, magnetic, water, hydrogen, oxygen, zero point or vacuum or radiant energy and/or cold fusion and may also include other potential sources of cosmic energy."

Millin sought financing from any investors who would listen. He ran what was in effect an investors' meeting, without the required prospectus documents, which I attended. We have Rossi's invoice dated January 2012 to Millin's company for $100,000 euros (then US$131,000).

Following the media exposés of that month by Dick Smith and me, Millin was unable to raise the capital, and Rossi's offer expired.

The business opportunity was then taken up by Roger Green of Sydney and New York. His firm Eco Global Fuels was, and still is, attempting to promote energy technologies, including "hydroxy gas, self-regenerating batteries, Quantum Resonance Technology, Tesla Scalar Waves, and a hydrogen fractal antenna."

Green saw our material debunking E-Cat but preferred to believe Rossi and the many scientists supporting E-Cat. Green travelled to Italy to view a demonstration, at which Rossi played the perfect host. Rossi remained very attentive, encouraging Green to expand his portfolio. This eventually included licenses for E-Cat sales in half a dozen countries, for which Green and his relatives scraped together over US$700,000.

Over the years, Rossi's warmth has decayed, and since 2017 he has failed to respond to Green's phone calls and emails. Presumably he is directing his efforts to fresh pastures. I will leave it to readers to assess the chances of Green, and the other investors around the world, ever seeing their capital again, let alone the expected generous returns.

Meanwhile, I rang Millin for a follow-up. I hoped he might say "Thanks, guys. You saved me from disaster." Instead he complained bitterly, "You guys ruined me."

These personal stories from Australia serve to reinforce the extreme damage done to individuals and families when "impossible" inventions are supported by experts who should know better.

—Ian Bryce

ically of E-Cat: "The many Rossi demonstrations in 2011 suggest LENR may produce 'useful' quantities of heat [up to 15KWs?]."

NASA even produced a concept of a spaceplane powered by LENR (Zawodny 2011). What next—flying carpets?

Hopefully these scientists will reexamine the evidence and retract their statements supporting E-Cat, giving some closure to the investors I know who have run up huge debts, jeopardizing themselves and their families.

Test Setup Described

What did the scientists see? We have detailed information from their report (Kullander et al. 2011) and numerous photographs and videos posted online by Lewan.

The small reactor sits on a tabletop. Rossi says there is an inner copper chamber containing nickel, hydrogen, and a secret catalyst, where cold fusion is claimed to occur. There is a port at the top for admitting hydrogen. This chamber is surrounded by a copper enclosure (visible in a bare unit also on the table), which guides a flow of water. In the operating unit, everything is wrapped in insulation.

The reactor has about six wires running from a blue box that is plugged into a regular Italian 230V power outlet. The power from the mains is monitored by voltmeter and ammeter and gives (on this occasion) 345 watts of input electrical power.

The blue box has been inspected and contains several power phase controllers (the industrial equivalent of light dimmers) controlled from an attached PC—certainly no significant batteries or other source of power.

Water is pumped into the bottom of the reactor, and (after fifteen minutes warm up) the supposed nuclear reaction sets in and a steam/water mixture issues from the reactor via a hose to a drain. The flow and temperatures are monitored—in this case 18°C (64°F) entering and 100°C (212°F) exiting.

Lewan's detailed photographs and videos helped confirm that there were no hidden pipes or wires.

Rossi calculated the power generated assuming only steam out, which gives 4.7 kilowatts, showing a CoP (coefficient of performance) of 14. Several commentators have questioned this claim, but I calculate that even if only 10 percent of water is vaporized, the power is 1020 watts, giving a gain of 3.0. This situation prevailed for over six hours.

This represents a large production of energy, which Rossi attributes to cold fusion. The Swedish scientists, and many other observers, including me, have estimated the volume and mass of the equipment and hence ruled out (as the source of power) hidden batteries, phase change materials, chemical reactants, etc.

A similar setup with some variations was used in at least seven tests up to April 2011, with most showing a significant power production (under the most pessimistic assumptions). This resulted in all those observers supporting excess energy, which they attributed to a hitherto unknown source, such as cold fusion.

With a world-changing energy revolution in sight, the blogosphere went wild in a search for other explanations. Chemical and physical sources were postulated but ruled out. The tables had been searched for hidden wiring. One observer speculated that microwave power was being beamed into the reactor (at gonad level) from a powerful transmitter in the next room, even as the observers walked around!

Meanwhile, I continued to investigate. The blue box, in particular, held my attention. While not containing batteries, the wiring was a tangled rats nest, in contrast to Rossi's otherwise neat constructions. Was that concealing something? James Randi often told us that a skeptic's training should include vigilance for trickery. And the best place to hide something is in plain sight.

In January 2012, I reported to Smith that there were too many bad signs causing doubt that the invention is real. These included the out-of-character blue box, all of Rossi's history, and the lack of a theory by which the energy output would be possible. Smith would not invest, and neither should others. This got good media coverage.

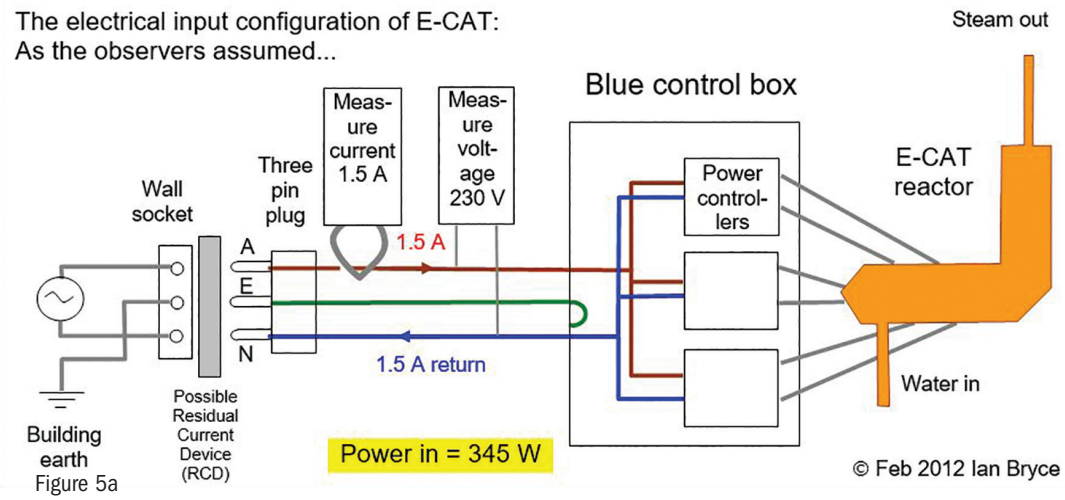


Figure 5a

Figure 5: Test configurations as deduced from documentation: (a) as the scientists assumed, and (b) according to the earth wire hypothesis.

Eureka!

On January 19, 2012, the likely answer came to me in my sleep. My subconscious must have been working overtime.

The diagram in Figure 5a shows the relevant equipment layout, as all the scientists believe. The key is the measurement of electrical power from the Italian wall plug, which is clearly described in the reports and shown in photographs. A clamp ammeter measures the current in the active wire, while a voltmeter measures between active and neutral. Multiplying the two readings normally gives the power supplied. The earth wire is for safety protection and normally carries no current.

The diagram in Figure 5b shows how I believe Rossi could have generated his results. The earth wire can be retasked, by connecting it to the active pin in the power plug, and also to additional "B" power controllers in the blue box. Thus, it can be used to smuggle in extra power past the metering. This power goes to two of the controllers and their respective heating elements in the reactor.

How does the earth wire hypothesis fit the observations? A detailed account is given (Bryce 2019c). In summary:

- The maximum power capacity can be estimated. The earth wire could bring the total current to about thirteen amps without getting noticeably hot, making the total power around 3100 W. Actual results from tests range from 2000 to 3000 W. We see that all the figures for output heat (supposedly nuclear) are at or just below the capacity of the power outlet used to control the devices. This includes four models of reactor, which one would expect to behave differently.
- How could one conceal the changed wiring? Easy: make a tangle of wires in the blue box so the interior can be safely examined and photographed even during operation.
- The setup could survive the closest examination when offline, because the connections at both ends could be restored in a few minutes, leaving no evidence.
- And what if an observer should take the initiative to check the current in the earth? Rossi is seen to hover over the keyboard and would be able to turn off the extra controllers should a scientist approach the metering. This would restore the earth lead current to zero, while briefly reducing the heating. In fact, my estimated heat production graph shows just such a drop.
- His explanation for constant attention was that the reaction needed his diligent monitoring and adjustment. Could it be that the *observers* needed constant monitoring?

We reexamined all E-Cat demonstrations and found that all five documented tests from December 2010 to October 2011 were fully compatible with the earth wire hypothesis.

Earth wires are provided for a reason. When retasked, a simple problem in the wiring could now result in the entire apparatus (cases, copper, water) becoming live and electrocuting the observers. If it was retasked, one wonders what passed through Rossi's mind.

On this basis, Smith and the Australian Skeptics went public with our hypothesis—an inadvertent misconnection of the earth wire. The blogosphere responded: "Don't be silly, that could not possibly be accidental!"

It was time to set a trap. In February 2012, Smith offered Rossi one million dollars, with no strings attached, if he would let a scientist take proper measurements and examine the earth wire during operation (see "Dick Smith's Challenge to Rossi" in Hassani's January/February 2019 SI article, p. 40). Should Rossi be genuine, he would no doubt eventually get a Nobel Prize, and the skeptics team would be proud of having helped verify it. Instead, Rossi refused and said he would have nothing to do with the "Aussie roadkill." He called Smith a "snake" and me his "puppet snake."

That was the confirmation we needed; there was no reasonable doubt now. Needing a bigger impact on the global scene to stop further investment money being wasted on Rossi, Dick Smith got a media splash by declaring E-Cat a fake.

We prepared and distributed a detailed account with many reference documents. Our magazine carried the story (Bryce 2012).

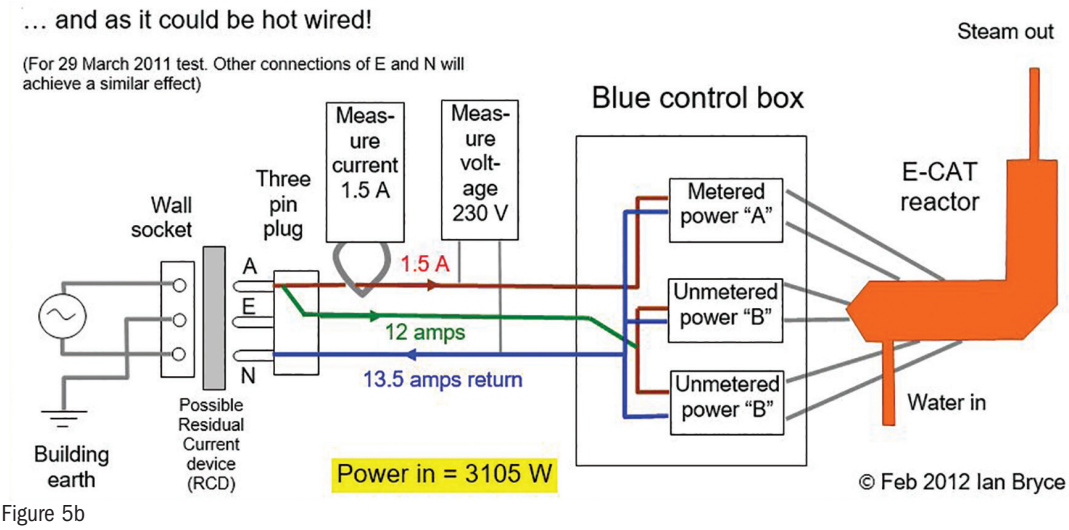


Figure 5b

Rossi then ceased demonstrations of the copper E-Cat. He came up with a second type—a large metal box, claimed to produce more heat at 27 KW. Several observers pointed out, and my observations have confirmed, many defects in the setup and measurements. No measurements of the earth wire were allowed.

Now, with hindsight, is there any doubt that Rossi was cheating? Possible explanations include:

- A real nuclear reaction—requiring new physics and an explanation of the missing radiation.
- Hidden energy storage such as batteries—ruled out by the scientists' inspections and calculations.
- A secret source of chemical or physical energy—ruled out as above.
- Hidden pipes or wires—ruled out as above.
- Invisible energy input—the best the blogosphere could come up with was a powerful microwave transmitter beaming in power from an adjoining room, boiling water at gonad height while people walked around.
- Earth wire retasking—easily done and explains all the observations.

If this wasn't enough, Rossi's reaction clinches the matter.

Rossi's explanation for constant attention was that the reaction needed his diligent monitoring and adjustment. Could it be that the *observers* needed constant monitoring?

Reactions to the Exposé

How did the world react? I wrote to NASA about their prior endorsement and received no reply. Regarding all seventeen scientists who supported E-Cat, I have not heard of any acknowledgement or retraction.

I contacted scientists Essén and Kullander on January 20, 2012, attaching my detailed hypothesis and asking them to check it. In their meticulous observations, did they see anything that would disprove my theory? The only response was "I guess not." Would they retract or modify their glowing report? They never did. In fact, on December 17, 2012, eleven months later, on Swedish public television, Kullander reinforced his initial conclusion with "Something happened here which cannot be explained by the power injected, some internal process."

It was a sad day for Swedish science, a skeptics society, and the Nobel committee.

Steven Krivit, a science journalist, runs the New Energy Times website (Krivit 2016), and is a long-time watcher of new energy proponents, including Rossi. It contains a very detailed timeline of the Rossi saga.

Although suspicious of Rossi and publishing many speculations, he was never able to find any trick in the demonstrations. I informed him of my findings and expected him to run an article, but he refused. Sour grapes, perhaps?

Mats Lewan (of the transmuting chickens) remained Rossi's loyal supporter. He wrote his book, which is essentially an authorized biography listing the recollections of Rossi. Lewan contacted me, trying to disprove my explanation. I carefully supplied all backup sources.

Nevertheless, his self-published book fails to mention me, my exposé, or the earth wire explanation. At least the book includes some feeble expressions of doubt. I understand Lewan has recently parted company with *Ny Teknik*, which had been under fire from readers.

The top-class Swedish Reference Group persisted in trying to arrange a test to demonstrate the validity of the invention (Lewan 2014, 132, 226). The test was financed by the Swedish Alba Langenskiöld Foundation and performed at the accredited Svedberg Laboratory in Uppsala, just north of Stockholm.

Rossi and an assistant arrived with the E-Cat in a van. But several delays ensued, according to Lewan's account. First, Rossi insisted on dismantling the E-Cat to show them the interior, but reassembly required sealant that took days to cure. Then Rossi refused to accept the semiconductor-type temperature sensors supplied by the laboratory and wasted another day obtaining thermocouples from a distant source.

The schedule required that the test take place on April 25, 2012. The observers reported zero energy production. Rossi blamed this on the uncured sealant coming unstuck. Thus, the test was declared null.

The affair was reported back to the Reference Group, but they were not deterred. They continued to attend and report on tests of later Rossi devices such as HotCat in 2013, thus providing solid credibility for an impossible invention. They never contacted me or acknowledged that all the 2011 tests (their *raison d'être*) had been shown to contain a major flaw.

Megawatt E-Cat

The story of Rossi's Megawatt Reactor is equally dramatic. Previous cold fusion claims reported very low powers such as twenty-six milliwatts. Rossi's first E-Cat was claimed to produce around 30 kW. Not satisfied with that, his next model produced a claimed one megawatt—about 30 million times more. Now that's ambitious. One was built comprising 102 small E-Cats in a blue shipping container.

Observers reported that there was always a 0.5 MW generator set running nearby and connected to it. Rossi claimed this was to start and control the reaction, but he refused to allow

Rossi's Latest Reactor 'Revealed' in January Video

Amid much fanfare, Andrea Rossi released a new E-Cat product to the world in a live video stream on January 31, 2019.

The video opened with a puppet show starring Rossi and Galileo in mutual admiration. Three hours later (for those still awake), it closed with a song "I Believe in E-Cat."

The E-Cat SK was dramatically unveiled—a blue box with fittings and plumbing at the top. Rossi said he was naming it in memory of the deceased Swedish scientist Sven Kullander who gave unswerving support (see main article)—not an honor I would seek. It is reported "AVAILABLE NOW" for lease to factories as a source of heat. It will be controlled from E-Cat Central via the internet.

Much of the video consists of seven windows, each purporting to show some measurements of an operating E-Cat. Rossi starts the narration, but an American voice takes over.

There is no overall configuration shown—a common failing of Rossi's documentation. The inputs, outputs, and measurement points are not defined, making the results largely meaningless.

A whiteboard of calculations is presented, suggesting that the core consists of a very hot plasma in a package of volume 1.0 ml (about a fifth of a teaspoon).

With the inside of the E-Cat revealed, the core is seen glowing brightly. A spectrometer shows the peak spectrum to be 0.36 microns wavelength (ultraviolet), from which the Wien Law gives the temperature as 8,111°Celsius (about 14,000°F). This is much hotter than the surface of the sun! Hence the radiated power is estimated at an astounding 22,000 watts. This matches the claimed overall performance.

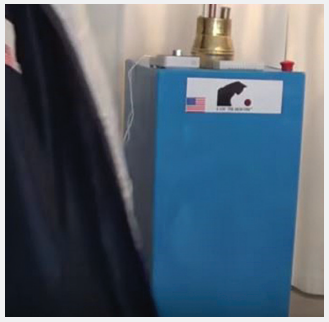


Figure 1. The dramatic unveiling of E-Cat SK reveals a blue case with fittings at the top.

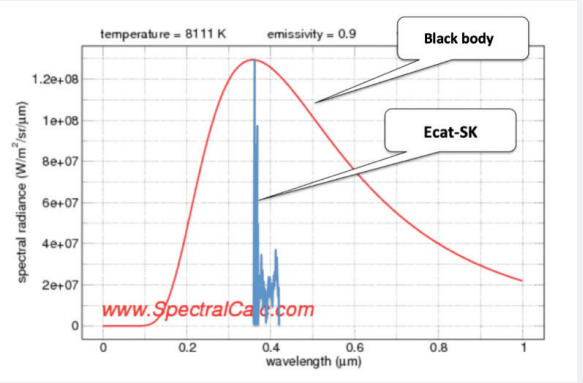


Figure 2. The narrow spectrum of the glowing reactor is suggestive of a simple laser source rather than a 14,000°F nuclear reaction.

Meanwhile, the input electrical power to the E-Cat is claimed to be 0.8 milliwatts. This gives an enormous coefficient of performance (CoP, or power gain) of 27 million.

Such an intense nuclear reaction must, according to the textbooks, release much deadly radiation. Yet the meters show zero ionizing radiation and no neutrons. Fortunate for the bystanders!

But wait ... there is a problem. The temperature calculation relies on the source being a blackbody. An astute observer has commented that the spectrometer shows a spike at a single wavelength. This is characteristic not of a hot blackbody such as a plasma but a laser! Could the "reactor" contain only a simple light source?

Given that in eight years Rossi has failed to deliver a working product, we will not hold our breaths.

Note: The video is available at https://www.youtube.com/watch?v=gw_oa8MvdQk.

—Ian Bryce

measurements. This one cold fusion plant was apparently sold and resold several times as investment deals went sour.

The Greek company Defkalion at first licensed Rossi's technology following the demonstration in October 2010. They set up test labs and production facilities in Greece (as evidenced in glossy brochures). They claimed to be ready to produce reactors for the home, called Hyperion. However, they soon fell out with Rossi, and he accused them of stealing his technology. (The earth wire technology? I asked.)

A later Rossi version is designated E-Cat HT or Hot-Cat for short. It glows visibly hot when powered from a control box. From November 2012 to March 2013, it was demonstrated for scientists largely from the Swedish Reference Group. They reported very detailed measurements (Levi 2013), but it seems noncritically, despite the earlier E-Cat exposure.

There is a link between Rossi's E-Cat and the 1989 Fleischmann and Pons cold fusion claims (SI, January/February 2019). When Fleischmann died in 2012, unshakable supporters rallied to fund a Martin Fleischmann Memorial Project. They attempted to replicate Rossi's E-Cat results. However, the attempt ended explosively in 2015 after the reactor heated to over 1000°C.

Figure 6. Rossi's 1 Megawatt E-Cat built into a shipping container. He reported it sold to unnamed buyers on several occasions.

Industrial Heat

There is a growing community of dissatisfied investors. The latest saga is Industrial Heat, or IH (Lewan 2014). Representing international investors, this company formed an agreement with Rossi in 2012. IH paid a $1.5 million deposit to Rossi for a 1 MW plant, including a test with their engineer present. Results were not published, but IH accepted the test and then paid Rossi $10 million for the next stage. Rossi delivered the plant to IH's site in North Carolina, for a one-year test. If the test was successful, $89 million was to be paid. IH would get a license to sell in many countries, plus full disclosure of the technology so they could manufacture it.

However, Rossi insisted the plant instead be moved to Florida, on the pretext that there was a customer who would pay $1,000 per day for the 1 MW of power. Rossi had total control over access to this site, which was tenanted by a Rossi shell company. The energy customer was never named or sighted, and someone pointed out a major flaw in Rossi's story: a room that size could not absorb the claimed million watts of heat.

In February 2015, the test reportedly commenced. But Rossi prevented access for IH engineers to see their own reactor being tested (Lomax 2018)! IH declined to pay the $89 million, and Rossi sued them for it. It is reported that both sides settled in 2017.

Conclusions

Australian Skeptics have a simple test for evaluating extraordinary claims: the three-legged stool test. When faced with claims of new science, ask three questions:

- Is there real evidence it works?
- Is there a theory that at least makes it possible?
- Does the track record of the claimant support his/her credibility?

If all legs are sound, the claim stands up. If any leg is broken, it does not stand up now but might be worth watching. If two or three legs are faulty, it is not worth pursuing at all. Rossi's E-Cat cold fusion claim is clearly left without a leg to stand on—there is no real doubt about it being a fake.

Who are the victims of Rossi's claims? First, the investors of course. But why do they keep coming when a simple due diligence search would reveal the exposure?

Second, investment and research efforts have been diverted away from real green energy techniques, thus hampering the efforts to provide affordable energy. Such false leads also hinder measures to reduce climate-changing carbon emissions, to the detriment of the natural world and mankind's future.

The endorsements of scientists, some NASA officials, a leading skeptic, and even a Nobel laureate have confused those striving to understand new technologies. Respect for science has been eroded.

We scientific skeptics must do more to separate real advances from the scams. ■

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Ian Bryce qualified in physics and engineering and worked as an aerospace engineer. He lectured at the University of NSW for seven years. Since 1981, he has led science-oriented investigations for the Australian Skeptics and coordinated their $100,000 Prize.

Further Comments on E-Cat Claims

THOMAS R. CASTEN

Editor's Note: Tom Casten founded and led multiple companies over thirty-nine years that successfully deployed the commercial model proposed by Leonardo Corp of using private capital to fund industrial heat and power plants in return for long-term contracts to supply customer heat and power. He knows a great deal about the science, technology, and economics of supplying industrial and institutional heat and power. We asked Casten to review the new E-Cat presentations and provide his take on the technical and commercial likelihood that this renamed approach to cold fusion could work and provide useful energy to the world's industrial and institutional users, as claimed by founder Andrea Rossi.

In 1989, Fleischman and Pons claimed they had achieved "cold fusion," which could release the incredible energy of fusion without the bother of containing the incredible temperatures and scale of fusion in stars. Alas, other scientists could not replicate the results. A few believers hung on and renamed the process Low Energy Nuclear Reactions (LENR) to avoid the association with the discredited term *cold fusion*. One Italian gentleman, Andrea Rossi, apparently focused on the rebranded cold fusion while in jail in Italy for defrauding investors. In January 2019, Rossi posted a video stating that his company, Leonardo, was ready to sell a device dubbed "E-Cat" to creditworthy industrial companies.

I watched the entire three-hour E-Cat video but did not find the claims credible with respect to energy conversion technology, materials to handle the plasma temperatures, or even documentation of the basic energy inputs and outputs. Here's an overview.

Rossi's Gigantic Claims

Claimed new science: creating useful energy with not-so-cold fusion under a new name, involving plasma with 8,111 degrees Celsius temperatures.

Claimed materials breakthroughs: materials able to contain over 8,000-degree Celsius plasma without melting and insulation that prevents any of this heat from traveling to the outside of the small E-Cat box. The highest melting temperature of any material known to science is 3,800 degrees Celsius for hafnium carbide—less than half of the E-Cat claimed plasma temperature.

Claimed value of E-Cat energy output: Rossi claims an energy output fourteen times the energy input to E-Cat but fails to provide the simple measurements to verify the quantity of energy leaving E-Cat, leaving the viewer with no way to confirm the energy balance. The claim that E-Cat produces fourteen units of energy per unit of energy input is gigantic and potentially of great importance. Why doesn't the inventor allow the measurements to prove this claim that E-Cat generates energy from some internal source? One suspects a simple explanation: a true energy balance test would falsify the claims.

Actual E-Cat energy input could be higher than claimed, but Rossi refuses to allow confirming measurements. Ian Bryce, the chief investigator for the Australian Skeptics, believes that E-Cat demonstrations cheat by sending additional electric power through the ground wire (see preceding article). All Rossi needs to show actual energy input is to cut the ground wire or let others meter its flow, but he refuses to allow investigators to measure the ground wire.

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Bottom line: If the claims are true, Rossi could easily provide the data needed to determine the energy balance

without exposing any of the claimed fusion process, but he refuses. No one can independently verify the claimed excess of E-Cat's energy output over E-Cat's energy input, and thus no one can have any certainty about the validity of the claims. Rossi should allow the tests, and if observed energy output exceeds observed energy input, then something in E-Cat must be releasing energy. If the observed energy output is—as I suspect—less than the energy input, then E-Cat is not releasing any energy. The lesson: Do not believe in the magical powers of the Wizard of Oz before looking behind the curtain.

Rossi did allow a test in June 2012 by the Swedish Reference Group on an E-Cat prior model, but the observers reported zero energy production. This seems a good data point, but Rossi blamed the absence of energy production on a sealant problem and declared the test null and void (see the prior Ian Bryce article).

If the claims are true, Rossi could easily provide the data needed to determine the energy balance without exposing any of the claimed fusion process, but he refuses. No one can independently verify the claimed excess of E-Cat's energy output over E-Cat's energy input, and thus no one can have any certainty about the validity of the claims.

There is little value in discussing the scientific claims of fusion energy generation until we can see an independent energy balance that shows E-Cat is releasing energy. However, I would ask one troubling question. If E-Cat does produce over 8,000 degrees C internal temperatures, why is the output temperature only 100 degrees C? Why would E-Cat destroy most of the potential work that could be done by this high process temperature? In 1824, Sadi Carnot showed that the maximum theoretical conversion efficiency of any heat engine would be equal to 100 percent, minus a fraction calculated as outlet temperature divided by the process inlet temperature, both stated in degrees above absolute zero. Absolute zero is zero in Kelvin and 263 degrees in Celsius, so the calculation is in degrees Kelvin (K). The higher the input temperature to the heat engine, the greater the theoretical efficiency.

For example, a modern Rankine Cycle power plant sends the steam turbine steam at roughly 1,360 K and then cools output from the steam turbine to 15 degrees C or 288 degrees K. The max theoretical efficiency of these plants is 100 percent minus the fraction of 288 K outlet divided by 1363 inlet or nearly 79 percent theoretical efficiency. After boiler losses, parasitic loads, and other inevitable losses, these steam plants convert around 40 percent of the energy in the fuel to electricity.

If E-Cat is producing 8,111 degrees C, or 8,374 degrees Kelvin, it could, using Carnot's formula, theoretically convert almost all the input energy—96.6 percent—to electricity. But E-Cat provides energy flows at 100 degrees C, which has a theoretical efficiency of only 21 percent, and due to the diseconomies of small size, could probably not convert 5 percent of that energy into electricity.

Why would an inventor who claims to have mastered fusion in a small box and learned how to contain incredible high temperatures then offer an E-Cat design that destroys the quality of the process temperature? The simplest explanation is that E-Cat does not produce temperatures much above 100 degrees C.

The final question is whether the 100 degrees C output of E-Cat has any value for industrial processes. In our experience with 300 industrial customers, this low-quality energy has very little value. Most industrial processes require higher temperatures, and most factories distribute thermal energy at temperatures of 250 degrees C to 300 degrees C.

Conclusion

The E-Cat presentation makes giant claims of scientific breakthroughs with no validation, which flashes red lights to skeptics but does not always dissuade potential investors. Skeptics seek to discourage others, including investors, from accepting large claims without demanding large proof. So far, Rossi has refused to provide *any* proof that E-Cat produces more energy than it draws from the plug. ■

Thomas Casten founded and operated several companies from 1977–2016 that designed, funded, built, and operated combined heat and power plants for industrial and institutional facilities that required thermal and electric energy. They include Trigen Energy Corp. and Primary Energy Recycling Corp. He is the author of *Turning Off the Heat*. He is also a fellow and former member of the Executive Council of the Committee for Skeptical Inquiry and a former board member of the Center for Inquiry. He lives in Hinsdale, Illinois.

Dragon Hoaxes: Piltdown Men of Creationism

Young-earth creationist authors often fall for hoaxes perpetrated centuries ago: taxidermic fakes that were billed as dragons. The fakes don't even resemble the very animals the creationist authors claim they are (dinosaurs and pterosaurs).

PHILIP J. SENTER

A little over a hundred years ago, an unscrupulous individual planted an orangutan's jaw and part of a human skull in the Piltdown gravel pit in East Sussex, England, in an attempt to fool scientists into believing that excavators had found an evolutionary intermediate between apes and humans. Some authorities immediately recognized the bones as exactly what they were, but enough scientists fell for the hoax for the new "species" to be given a scientific name (*Eoanthropus dawsoni*) and a nickname (Piltdown Man) and to be touted as a link between ape and human until it was definitively discredited in 1953 (Weiner 2003). Fossil-based hoaxes continue; in 1999, an article in *National Geographic* gave the name *Archaeoraptor* to a specimen that seemed to be an evolutionary intermediate between dinosaurs and birds.

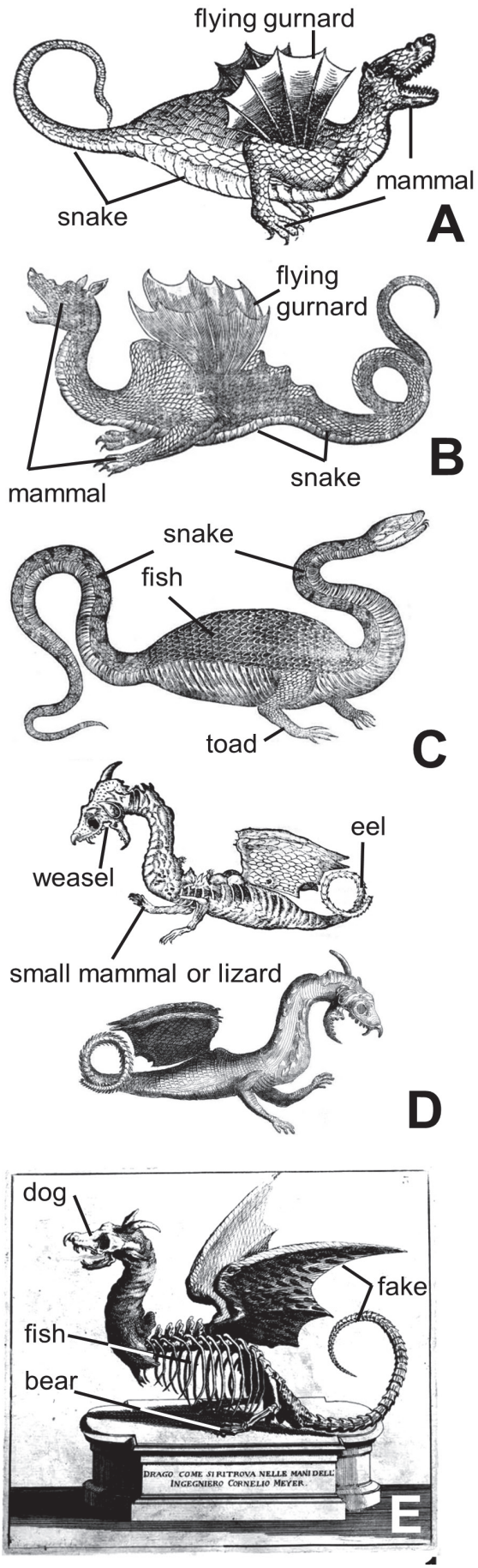
A subsequent study showed that it was composed of at least two—and possibly as many as five—fossil skeletons, representing at least two species (the ancient bird *Yanornis martini* and the dinosaur *Microraptor zhaoianus*) that had been attached to make a composite that looked like the skeleton of a single animal (Xu et al. 2000; Rowe et al. 2001; Zhou et al. 2002). Unsurprisingly, the exposure of the two hoaxes has provided much literary fodder for young-earth creationist (YEC) authors, who claim that the biblical account in Genesis is an accurate record of events. Important corollaries of that claim are that dinosaurs, humans, and all other kinds of organisms were created during the same week about 6,000 years ago, and that no "kind" of organism has evolved into any other "kind." In their arguments for the latter corollary, YEC authors make frequent use of the Piltdown and *Archaeoraptor* forgeries as poster children for "evolutionary intermediates" that aren't.

Despite the pair of forgeries, a plethora of genuine fossil intermediates demonstrate that humans evolved from apes and that birds evolved from dinosaurs (Stein and Rowe 2013; Xu et al. 2014). But even so, the large number of scientists who fell for the two forgeries is embarrassing, and the YEC community has never let us forget it. In publication after publication (e.g., Comninellis 2001; Bergman 2004; Sharp 2010; Gilmer 2011; Gilmer 2013; Lee 2013; Clarey 2015), YEC authors slam scientists for having believed those two ruses. Such criticism is understandable. But it is also somewhat hypocritical, for the YEC literature is replete with cases in which its own authors have fallen for taxidermic "dragon" hoaxes. To make matters more embarrassing for the YEC movement, the fake animals in question are *obvious* fakes that don't even resemble the real animals that the YEC authors claim that they are: dinosaurs and pterosaurs that recently coexisted with humans.

The practice of selling fake animals in the form of taxidermic composites to gullible buyers has had a long and amusing history.

Fish-Finned Fakes from Egypt

The practice of selling fake animals in the form of taxidermic composites to gullible buyers has had a long and amusing history. The stuffed jackalopes (rabbits to which a taxidermist has attached deer antlers or pronghorn horns) sold in American gift shops represent but the latest chapter in a centuries-old saga that also includes fake mermaids, fur-bearing fish, and animals sprouting from plants (Dance 1976). In the sixteenth century, artisans in Egypt made fake "dragons" by adding a covering of snake skin to specimens that included mammalian heads and paws with "wings" composed of the pectoral fins of the fish called flying gur-



nards (*Dactylopterus volitans*) (Senter and Klein 2014). The French naturalist Pierre Belon illustrated one of those fakes in a book of drawings that he made during travel in Egypt and Arabia (Belon 1557) (Figure 1a). He described and again illustrated it in a subsequent book that recounted his travels around the Mediterranean (Belon 1588). The Italian naturalist Ulisse Aldrovandi mentioned Belon's account in a posthumous book on snakes (Aldrovandi 1640). In that book, he illustrated Belon's specimen and also described and illustrated a second, similar Egyptian fake that was made from an identical assortment of animal parts (Senter and Klein 2014) (Figure 1b). Neither Belon nor Aldrovandi gave any indication that they were aware that the two Egyptian

Two things make Cooper's interpretation not only wrong but laughable: The first is that tyrannosaurs and other predatory dinosaurs lacked armor plating. The other is that the "predatory dinosaur" and its "armor" in the medieval carving are merely a lion and its mane.

"dragons" were anything but genuine. German naturalist Conrad Gessner also mentioned Belon's account and reproduced Belon's drawing in an encyclopedia of snakes (Gessner 1589), as did the English author Edward Topsell (1608).

Hundreds of years later, people are still fooled by the Egyptian fakes, but the hoaxing has taken bizarre turns that reveal deep ignorance and gullibility. In a 1992 article in the YEC journal *Creation Ex Nihilo Technical Journal*, Bill Cooper reproduced Topsell's (1608) illustration of Belon's "dragon" and suggested that the artist had drawn a *Tyrannosaurus* that had been seen at such a distance that its armor plating had been mistaken for wings. In support of the notion that a tyrannosaur's armor plating could be mistaken for wings, he cited a medieval carving of an animal that he interpreted as a

Figure 1. Five fake dragons that young-earth creationist authors claim to be dinosaurs or pterosaurs: A. Belon's Egyptian fake, from Belon (1557); B. Aldrovandi's Egyptian fake, from Aldrovandi (1640); C. Aldrovandi's wingless dragon, from Aldrovandi (1640); D. Cardinal Barberini's dragon, from Faber (1651) (top) and Kircher (1664) (bottom); E. Meijere's dragon, from Meijere (1696).

predatory dinosaur with wing-like armor plating. Two things make Cooper's interpretation not only wrong but laughable: The first is that tyrannosaurs and other predatory dinosaurs lacked armor plating. The other is that the "predatory dinosaur" and its "armor" in the medieval carving are merely a lion and its mane (Jewell 1986; Senter 2018).

YEC author John Goertzen partially corrected Cooper's mistake in a subsequent letter to the editor of *Creation Ex Nihilo Technical Journal*, then added mistakes of his own. He correctly noted that Topsell's illustration was a copy of Belon's drawing and that it was drawn from a specimen that was seen up close, not from a distance (Goertzen 1993). He then suggested that the specimen's wings were genuine but shriveled and implied that it was a pterosaur. In a subsequent publication he identified the specimen as the pterosaur *Dimorphodon macronyx* (Goertzen 1998). Following suit, YEC authors David Woetzel and Brian Thomas listed Belon's account as a historical reference to pterosaurs (Woetzel 2006; Thomas 2013).

YEC author James Gilmer published a different view of Belon's specimen in his provocatively titled 2011 book *100 Year Cover-up Revealed: We Lived with Dinosaurs!* and a later book (Gilmer 2013). He reproduced Aldrovandi's illustration of Belon's specimen and identified it as a "land dinosaur." He proposed that its wings were appendages that were used like the Australian frilled lizard (*Chlamydosaurus kingii*) uses its frill: for defensive or aggressive displays. As an alternate proposal, he suggested that a bipedal dinosaur with such appendages "moved [them] like wings to lighten the creature's body for faster running."

YEC authors have not specifically mentioned Aldrovandi's second Egyptian fake. However, Woetzel (2006) cited Aldrovandi as someone who had written about pterosaurs, in apparent reference to the book in which Aldrovandi had described both Belon's specimen and the second Egyptian fake (Aldrovandi 1640).

The Egyptian fakes are so dissimilar to pterosaurs that it is baffling that anyone would mistake them for such animals. The wing of a pterosaur has but one strut: the forelimb, including the elongated fourth finger, which runs down the leading edge of the wing (Figure 2). In contrast, the Egyptian fakes have multiple struts within each "wing." A pterosaur wing is broad where it meets the body and tapers to a narrow point at the tip, whereas the "wings" of the fakes are narrow at the base, widening toward the tips. The "wings" of the fakes have scalloped edges, whereas those of pterosaurs do not (Figures 1a and 1b). While the "wings" of the fakes look nothing like the wings of pterosaurs, they are dead ringers for the pectoral fins of flying gurnards, which is exactly what they are (Senter and Klein 2014). In addition, the "legs" of the fakes conspicuously have an elbow (pointing backward) where a knee (pointing forward) should be. This reveals that they are forelimbs, not legs. In a pterosaur, the forelimb and the wing are one and the same, not two separate appendages. The tails of the fakes are coiled, whereas the tails of long-tailed pterosaurs were held stiff and straight by bony rods that prevented coiling (Wellnhofer 1991). As if that weren't enough, the skin of pterosaurs was covered in fur-like filaments (Bakhurina and Unwin 1995; Lü 2002), not scales. In contrast, the skins of the fakes are scaly, and their bellies are adorned with the enlarged ventral scutes that only snakes possess. To anyone with even a rudimentary knowledge of comparative anatomy, it is obvious at a glance that the Egyptian specimens are taxidermic composites. The identification of such hoaxes as genuine dinosaurs or pterosaurs is therefore an excellent example of what I have previously dubbed apnotheriopia, or dead varmint vision: the tendency of YEC authors to see dinosaurs and pterosaurs (dead varmints) where there are none (Senter 2013).

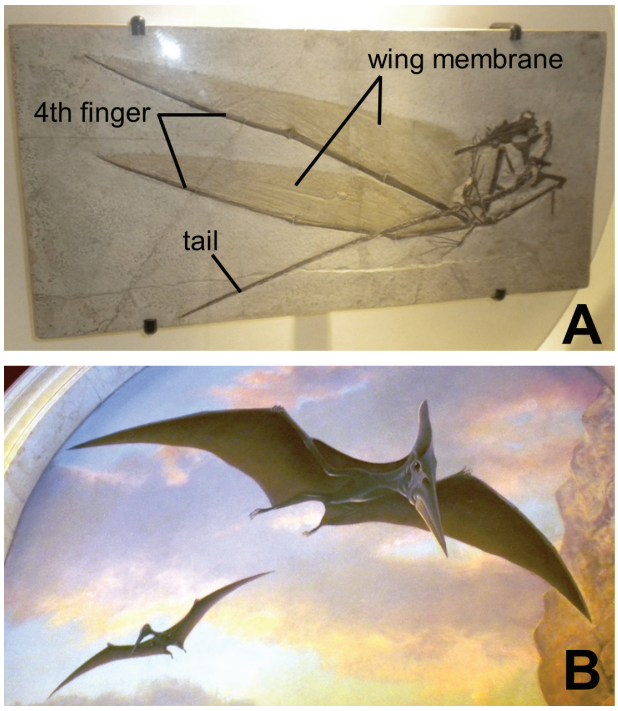


Figure 2. Pterosaurs, showing the dramatic differences between their anatomy and those of the fake dragons from Figure 1: A. Fossil of the pterosaur *Rhamphorhynchus muensteri* with wing imprints; B. Anachronistic painting of the pterosaur *Pteranodon longiceps* (above) and *Pterodactylus antiquus* (below), which were not contemporaries, by A. Astori and A. Brown (1942) on a wall of the American Museum of Natural History, New York.

Aldrovandi's Wingless 'Dragon': Forelimbs, Not Four Limbs

Aldrovandi (1640) described another dragon hoax that continues to fool YEC authors (Figure 1c). In this case, the hoax originated in Italy and came with a back story: a herdsman had supposedly come across the dragon near Bologna in 1572 and killed it when it startled his oxen (Aldrovandi 1640). The specimen consisted of a European grass snake (*Natrix natrix*), to which an artisan had attached the forelimbs of a toad and the midsection of a fish (Senter et al. 2013).

Several YEC authors (Taylor 1979; Ham et al. 1991; Niermann 1994; Ham 1998; Ham 2006; Perloff 1999; Comninellis 2001; Gilmer 2011) have identified the specimen as an example of *Tanystropheus*, a long-necked aquatic reptile from the Triassic period. Other YEC authors have identified the

"dragon" simply as a match for "ancient reptile-like creatures" (Taylor 1987; Phillips 1994) or as a bipedal dinosaur (Gilmer 2013). This underscores how little attention such authors pay to the animals that they identify as Mesozoic reptiles, because the "dragon" had only two limbs (with elbows), whereas *Tanystropheus* was a quadruped (Wild 1973). Even bipedal dinosaurs had four limbs, unlike the "dragon's" mere two. It is not plausible that Aldrovandi's artist omitted a pair of limbs that were present on the specimen, for the specimen was in Aldrovandi's possession (Findlen 1996), and he insisted that his artists illustrate what they saw in front of them without taking artistic liberties (Olmi 2007).

Another taxidermic dragon hoax, acquired by King Louis XIII of France, included the skull of a weasel, scaly reptile skin on the torso, the tail skeleton of an eel, the forelimbs of a small mammal or lizard, and scaly wings of unknown origin.

Cardinal Barberini's 'Dragon': Weasel-Headed Wonder

Another taxidermic dragon hoax was acquired by King Louis XIII of France, who gave it to Cardinal Francesco Barberini in the seventeenth century (Bartholin 1678). It was subsequently illustrated by the anatomists Giovanni Faber (1651) and Thomas Bartholin (1678) and the Jesuit scholar Athanasius Kircher (1664) (Figure 1d). The specimen included the skull of a weasel, scaly reptile skin on the torso, the tail skeleton of an eel, the forelimbs of a small mammal or lizard, and scaly wings of unknown origin (Senter and Klein 2014).

Woetzel (2012; 2017b) listed the specimen as an example of a pterosaur that had survived into historical times, despite that it resembles a pterosaur about as much as a walrus resembles a gorilla. The specimen has several of the non-pterosaurian traits of Belon's and Aldrovandi's Egyptian fakes: scaly skin, elbows where knees should be, scalloped edges on "wings" with narrow bases, and a tail that is both long and coiled. In addition, it has other non-pterosaurian traits: wings that arise from the lumbar region instead of the shoulders, five "toes" (pterosaurs have only four) on each elbow-bearing "hindlimb," a jawbone with a diagnostically mammalian coronoid process (an upward-jutting prong near the jaw joint), and a diagnostically mammalian division of the teeth into incisors, canines, and cheek teeth (premolars and molars) (Senter and Klein 2014). This weasel-headed specimen resembles a pterosaur only through the pterosaur-colored glasses of dead varmint vision.

Cornelius Meijere's 'Dragon': Still Dogging the Gullible

A fifth dragon hoax that continues to fool YEC authors was displayed in Rome in the late seventeenth century. The Dutch civil engineer Cornelius Meijere published a detailed drawing of it in 1696 (Figure 1e). The specimen included the skull of a domestic dog, the forelimb bones of a bear, the ribs of a large fish, and fake wings, all with "skin" covering the junctions between the parts of the different animals (Senter and Wilkins 2013). A prominent horn was added to the roof of the skull. As with the other fake dragons, several non-pterosaurian traits are present: five-toed "hindlimbs" with elbows, scalloped wings with narrow bases arising from the lumbar region, multiple struts within the wings, a tail that is both long and coiled, a coronoid process on the jaw, and division of the teeth into incisors, canines, and cheek teeth. Nevertheless, Goertzen (1998) and Woetzel (2006; 2012; 2017b) identified the dog-skulled specimen as a pterosaur, an error as incongruous as the mistaking of an ostrich for a vampire bat.

The specimen is so obviously unlike a pterosaur that one does not have to be a paleontologist to see the difference. This is exemplified by the reaction of Pondanesa Wilkins, my coauthor on the article in which we exposed the hoax (Senter and Wilkins 2013). She was but an undergraduate student at the time, and after one glance at Meijere's drawing of the "dragon," she was so floored that Goertzen had thought it was a pterosaur that she exclaimed "Did he even look at [the drawing]?" Indeed, he did, for he published a copy of the drawing, along with his assertion that it was a recently killed specimen of the pterosaur *Scaphognathus crassirostris* (Goertzen 1998). He based that identification on its having both a long tail and a crest (the horn), despite that *S. crassirostris* is a crestless species (Senter and Wilkins 2013). Dead varmint vision, like hope, springs eternal.

In British slang, an extreme example of something "takes the biscuit." In this case, YEC dead varmint vision takes the dog biscuit. To seek evidence of human-pterosaur coexistence in Meijere's dog-headed "dragon" is truly to bark up the wrong tree.

Closing Thoughts

The sixteenth- and seventeenth-century hoaxers who constructed the composite "dragons" would doubtlessly be tickled to know that their creations are still fooling the gullible at the dawn of the twenty-first century. Sadly, such dragon hoaxes are not the only Piltdown Men of creationism. Advocates of the YEC view are routinely taken in by hoaxes. A newspaper article peppered with clues that it was a hoax (Kuban 2005) appeared in the *Illustrated London News* in

1856, claiming that a live pterosaur had been found encased in stone (Anonymous 1856). Over a century and a half later, the article continues to fool YEC authors, who claim that it demonstrates the recent existence of pterosaurs (Phillips 1994; Perloff 1999; Sharp 2010; McGlenn and McGlenn 2014). The Cardiff Giant, an oversized human sculpture that was buried as a joke and unearthed in 1869, fooled biblical literalists, some of whom were convinced that it was a genuine, fossilized example of one of the giants of Genesis (Rose 2005). The Granby Stone Idol, a stone with a carved dinosaur and incorrectly carved Chinese symbols that surfaced in Colorado in the 1920s (Brandon 1983), continues to fool YEC authors (Childress 2000; Woetzel 2017a). Alleged to be evidence of coexistence between dinosaurs and Chinese people in ancient America, it has long been known to be a hoax (Brandon 1983). The Silverbell artifacts, a collection of alleged evidence of a medieval Roman colony in Arizona, uncovered in the 1920s, include a sword with a carving of a dinosaur on it. YEC authors continue to cite the sword as evidence for human-dinosaur coexistence (Childress 2000; Helfinstine and Roth 2007; McGlenn and McGlenn 2014), despite the collection's exposure decades ago as a hoax (Burgess and Marshall 2009). The Burdick track, a giant human footprint that was carved into Cretaceous limestone in the 1930s, was exposed as a hoax in 1970 (Kuban and Wilkerson 2010). Nevertheless, it continues to be cited by YEC authors as genuine evidence that giant humans coexisted with dinosaurs (Helfinstine and Roth 2007; Wilson et al. 2007) and is still displayed as a genuine giant footprint in the Creation Evidence Museum of Glen Rose, Texas. The Acámbaro figurines, a collection of clay figures from Mexico that were planted in an archaeological site in the 1940s, include small sculptures that resemble dinosaurs. Although the collection was exposed decades ago as a hoax (Di Peso 1953; Carriveau 1976), YEC authors continue to cite the collection as evidence of human-dinosaur coexistence (Childress 2000; Helfinstine and Roth 2007; Gilmer 2011; Gilmer 2013; Woetzel 2012; Woetzel 2017a; McGlenn and McGlenn 2014). The Ica Stones, a collection of engraved stones from Peru, include several with illustrations of dinosaurs that include the postural and anatomical mistakes of dinosaur reconstructions from the mid-twentieth century. YEC authors continue to cite the collection as evidence of human-dinosaur coexistence (Helfinstine and Roth 2007; Gilmer 2011; Gilmer 2013; Woetzel 2012; Woetzel 2017a; McGlenn and McGlenn 2014), despite the public confessions by some of the hoaxers who made the engravings in the 1960s (Polidoro 2002).

One of the major hallmarks of YEC literature is the tendency of its authors to be easily fooled by obvious forgeries such as the fake dragons reviewed here. Another major hallmark is the tendency of YEC authors to continue to proclaim that such hoaxes are genuine long after the hoaxes have been exposed. YEC pots would therefore do well to acknowledge their own charcoal hues before denouncing any sooty stains among of the kettles of science. How are we to take seriously the criticism of YEC authors toward scientists for having been fooled by a pair of forgeries in the past, when so many of those very YEC authors continue to be fooled by so many forgeries in the present? To be taken seriously, YEC authors must, at a minimum, acknowledge exposed hoaxes as hoaxes and start employing a healthy skepticism to prevent being hoodwinked by charlatans in the future. They also must learn to muzzle the inane barking of the mental voices of dead varmint vision, a blithering burble that has made many a YEC author's writings an astoundingly silly circus of laughably misinformed blather. ■

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Philip J. Senter earned a PhD in biological sciences from Northern Illinois University in 2003 and teaches zoology and anatomy courses at Fayetteville State University in North Carolina. He has published seventy-four peer-reviewed articles, most of which focus on dinosaur paleontology, reptile biology, vestigial organs, and the testing of creationist claims. He has previously written in SI about creationist claims of alleged fire-breathing dinosaurs and, most recently (July/August 2018), an alleged dinosaur with breasts. He is the author of *Fire-Breathing Dinosaurs? The Hilarious History of Creationist Pseudoscience at Its Silliest*.

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Creationist Funhouse, Episode One: The Red Shift

Many people assume that young-earth creationism is based solely on the Bible. This is not so. To reconcile their literalistic interpretation of the Bible with the facts of science, creationists have to make up many miracles that are not recorded in the Bible. Their idea that God created the red shift to trick observers is one of those miracles.

STANLEY RICE

Editor's Note: This is the first of an occasional series of articles on the "Creationist Funhouse."

Look into the night sky. Unless it is obscured by light pollution or clouds, you cannot help but be moved when you see the magnificence of the universe. A humanist would be in awe that we stardust humans are part of this vast wholeness and that we are privileged to understand even a little bit of it. An adherent of a monotheistic religion would say the words attributed to King David, "The heavens are telling the glory of God."

But, according to young-earth creationists, both the humanist and the religious person would be very, very wrong. The reason is this: observations and measurements of the universe show that it is very old. Creationists believe, however, that God has warped the very young universe so that it just *looks* old. That is, what you see in a telescope and what an astronomer measures is a deception that God has created to trick us. The heavens and the earth do not declare the glory of God; according to creationists, they declare a lie. And the same is true of every other aspect of the natural world. From the chromosomes to the continents, God has manipulated the creation to look not only old but to look like it evolved. To creationists, there is practically nothing that you can observe in the heavens or the earth that you can believe at face value. It is all God's intricate and magnificent fraud.

It gets worse. Most people assume that creationism is 200-proof Christianity. But it is not. The trickery that they claim God has done is not mentioned in the Bible. None of it. The creationists just made it all up. They wave their Bibles in the air, but their beliefs are based on their own vivid and warped imaginations. They believe that you cannot understand the universe just by studying it or just by reading the Bible. You have to let them take you by the hand and lead you through the funhouse of tricks that God has played on us, a funhouse of warped mirrors and of balls rolling uphill. They consider themselves inerrant guides through this funhouse. Whenever they say that God made the universe look old and evolved, they obligate God to *have* done whatever they say he did. It puts God in the subservient position. It seems to go something like this: a creationist says God did something, then God causes this thing *to have happened* in the past. I feel as if I am inventing new verb tenses to try to get my mind around it.

Loraine Thompson

The purpose of this series of articles is not to beat up on creationists. I used to be a creationist myself, and I have written my share of articles and encyclopedia entries that throw creationists on the carpet. But readers of this magazine already know that creationists are wrong. Nobody, not even me, wants to read a tedious article whose conclusion is, "Therefore, creationists are wrong." Instead what I want to do by picking apart creationism is to invite you to explore a lot of fascinating things about the cosmos and have fun along the way.

Edwin Hubble

The fact that the Bible does not say whether or not Adam had a belly button did not slow Gosse down from creating an entire creationist mythology based on this idea.

The idea of God making a young universe look old is not new. In 1857, a writer named Philip Henry Gosse invented the *omphalos* theory of creation. *Omphalos* is the Greek word for navel. His reasoning was this: When God created Adam, he gave Adam a belly button, even though Adam did not have a mother. If God could do this for Adam, then God could do it for the whole cosmos. The fact that the Bible does not say whether or not Adam had a belly button did not slow Gosse down from creating an entire creationist mythology based on this idea.

But with each passing year the *omphalos* theory gets harder and harder to believe. In Gosse's day, all that God had to do was create some fake fossils in the sedimentary rocks and a vestigial organ or two, such as your appendix, to make the world look old. But today the evidence for an old, evolved universe has grown to prodigious proportions, which suggests that God did almost as much work spoiling his creation as he did in making it.

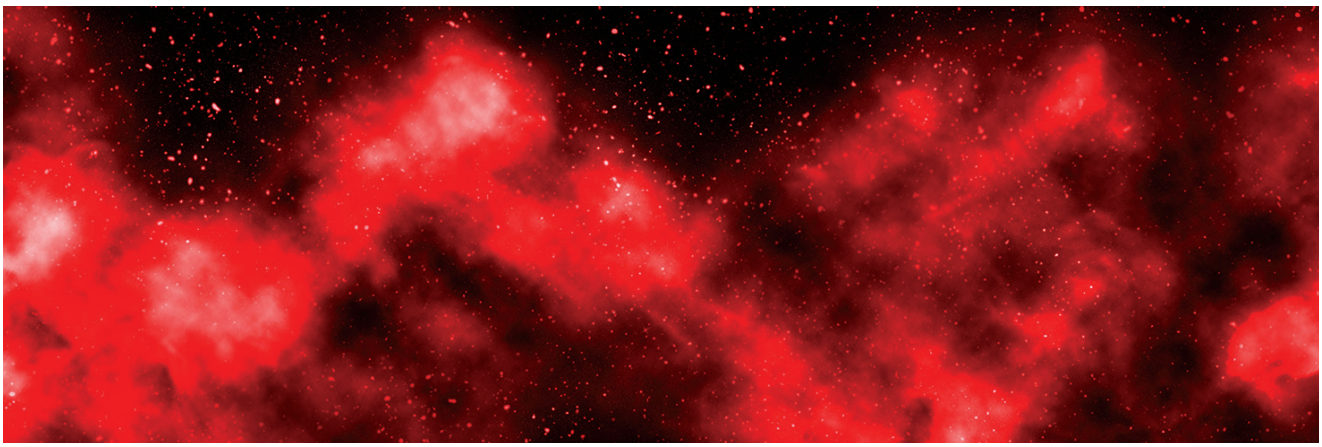
The Red Shift Problem

The immense age of the universe, and the answer to the mystery of its origin, came as a big surprise even to most scientists when astronomer Edwin Hubble and his collaborator Henrietta Swan Leavitt discovered them.

First, Hubble and Leavitt could tell how far away the galaxies were from Earth because, *within our galaxy*, stars known as Cepheid variables all have the same light intensity. Hubble found Cepheid variables *in other galaxies* and measured their light intensities. Light intensity decreases with the square of the distance. Hubble and Leavitt found that some galaxies were so far away that their distance can only be expressed in light-years, the distance light travels in a year. The universe turned out to be larger and older than most scientists previously dared to believe.

Second, if an object emits waves, then those waves are scrunched together (shorter wavelength) if the object approaches you and pulled apart (longer wavelength) if the object is moving away from you. This is known as the "Doppler effect." Most of us know about the Doppler effect because of its effect on sound waves. The whistle of a train or the horn of a car has a higher pitch when it approaches us and a lower pitch when it moves away. Meteorologists use the Doppler effect to determine the direction of winds. A radar source emits a beam of microwave photons, which reflects off the clouds. When meteorologists measure the returning microwaves, the change in their frequency indicates whether the clouds are moving forward or away and how rapidly.

Light also travels in waves. Therefore, an object that is moving toward us will emit light that has shorter wavelengths (a blue shift) and an object that is moving away from us will emit



Henrietta Swan Leavitt

light that has longer wavelengths (a red shift). Visible light has very short wavelengths, and we would never notice a red or blue shift on the headlights of trains or cars. But over universal distances, the red or blue shifts are measurable. Hubble and Leavitt detected red shifts in the light coming from *all* of the distant galaxies but not consistently in the stars of our own galaxy. This could only mean one thing: that the galaxies are moving apart, while the stars within each galaxy travel together. This is the famous red shift you have heard about.

Some galaxies are *billions* of light-years away—and yet we can see them. This means that the light has been traveling through outer space for billions of years. More properly, we would say that space itself has been expanding for billions of years. The universe must therefore be billions of years old. Furthermore, billions of years ago, a gigantic explosion (now called the big bang) created the universe, causing the galaxies to fly apart from one another.

So, what's the problem? A creationist could, we might think, simply say that God created the big bang. And some of them do. But they are at the liberal end of the creationist spectrum. They risk denunciation from other creationists and from fundamentalist pulpits, because the very same evidence that shows that the big bang happened shows that it happened billions of years ago. As a church sign near my place of work proclaimed, "Big Bang? You've got to be kidding. God."

From the creationist viewpoint, when God said, "Let there be light," he had to make sure that the light from each of the galaxies was red-shifted just the right amount, and the intensity of light of the Cepheid variables was adjusted just the right amount, to make the universe look billions of years old. And he did so while keeping the light perfectly on track so that, to human observers using telescopes, the stars and galaxies look perfectly in focus—perfect enough for those astonishing images from the appropriately named Hubble Space Telescope. God could not just create a giant red filter; he had to adjust the red-shift from *each individual* galaxy (see cartoon on p. 57).

There is another possibility. According to Answers in Genesis, a notorious creationist organization, God might have created light that gets tired. That is, when God first made the universe, light traveled much, much, much faster than the speed of light. (According to Einstein's relativity, the speed of light is a universal constant and is the fastest possible speed that anything can travel. Therefore, all post-Einstein physics must be wrong if Answers in Genesis is right.) But the light somehow got tired as it traveled, slowing down to the present slow rate of 186,000 miles per second. This tuckered-out light ended up with a red shift. Of course, this explanation has the same problems as the other: it has no scientific evidence and is not in Genesis. The creationist group that published this theory online should rename itself Answers Not in Genesis.

Creationists believe the Bible teaches that the whole universe is only a few thousand years old. The reason is, they say, that Genesis 1 says the creation took only six days. And to them this means six literal twenty-four-hour days. That is, Planet Earth days. Of course, the book of Genesis does not say this. In fact, other parts of the Bible use the word "day" (*yom* in Hebrew) in other ways. The creationists have chosen the twenty-four-hour-day interpretation, and they believe they cannot possibly be wrong. Their interpretation becomes inerrant. It is more likely that God altered all the light in the universe to make it look old than that maybe—just *maybe*—they interpreted Genesis incorrectly. Anything but that!

Perhaps the most amazing thing about the fake red-shifted light is that God did it not for the benefit of all human beings throughout history but for modern humans. Throughout human history, even during the first few centuries in which telescopes were available, nobody knew about the red shift or the big bang. God's hard work was done solely for the benefit of humans who lived in the twentieth century and afterward—post-Hubble humans, that is. This blends nicely with the assumptions of many modern fundamentalists, who believe that we humans, right now, are living in the climactic End Times, when "signs in the heavens" tell us of Jesus's imminent return and the coming of Armageddon and Judgment Day. In this view, we contemporary humans are the focus of God's attention and have been so from the beginning of time. From the beginning of the universe, God planned for his hard work to be revealed to those of us who are alive today. We who are alive today are the most important people in history, they think.

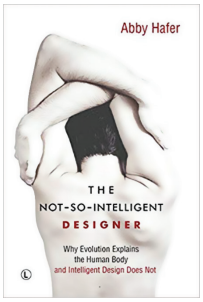
* * *

In the next installment, we will explore how God created a beautiful, peaceful Earth and then turned it into a monstrous realm of disease and death. You just thought that a Christian god would have made a beautiful world, but according to creationists, God made it ugly. ■

Stanley Rice is a professor of biological sciences at Southeastern Oklahoma State University in Durant and the author of five popular science books, most recently *Scientifically Thinking: How to Liberate Your Mind, Solve the World's Problems, and Embrace the Beauty of Science* (Prometheus Books). He has three decades of experience in college-level science education and dealing constructively with creationism.

Unintelligent Design

HARRIET HALL



The Not-So-Intelligent Designer: Why Evolution Explains the Human Body and Intelligent Design Does Not. By Abby Hafer. Eugene, Oregon: Cascade Books. 2015. ISBN: 9781620329412. 244 pp. Paperback, $31.00.

Intelligent design (ID) maintains that some features of the natural world are best explained by an intelligent cause (presumably God?) rather than by the natural process of evolution. That's nonsense; evolution explains the natural world much better. Abby Hafer has a doctorate in zoology and teaches human anatomy and physiology at Curry College. She was incensed by the claims of ID, so she wrote this book explaining the history and claims of ID, conclusively debunking it, and demonstrating that no intelligent designer could have created a human body with so many design flaws.

Creationists invented the term *intelligent design* to get around the U.S. Supreme Court's finding that creationism is a religion and to try to disguise creationist beliefs as science. They went back to their creationist textbook *Of Pandas and People* and replaced every mention of the word *creationism* with the words *intelligent design*, and every mention of *creationists* by the words *intelligent design proponents*. But they were careless. The new textbook famously had a cut-and-paste typo that read "cdesignproponentsists."

Hafer exposes the religious agenda of the creationist Discovery Institute as revealed in the infamous "Wedge" document and shows that the individual members of its staff disagree about almost everything. Some believe Earth is only 10,000 years old; others accept that it is billions of years old. Some believe every species was individually created by God; some accept that humans and chimpanzees have a common ancestor but say that doesn't explain the differences between the species. Some are HIV/AIDS denialists. Hafer comments, "I'm not sure that they could agree among themselves that gravity makes things fall down." There is only one thing they agree on: they want your children to be taught ID as science and expect you to pay for it.

Hafer chose to describe ten simple design errors, though there are many, many more. Because sex sells, she starts with a sexy example; she points out human testicles are positioned outside the body. Why? Because the human body is too hot for sperm production. That puts a vulnerable organ in a vulnerable position and creates all sorts of inconvenience. But the supposed creator designed some animals with retractable testicles and some with testicles that reside permanently inside the body, including frogs and elephants. Birds have a higher body temperature than humans, and yet they have internal testicles. Hafer asks whether the designer likes turkeys better than us and wonders if the designer is a turkey.

Her other examples of bad design include:

- The birth canal. Kangaroos don't have the problems humans have. Human women and babies often die in childbirth; obstetric fistulas result from difficult births; and one-third of pregnancies end in spontaneous abortion. Is the designer an abortionist?
- There is a species of jellyfish that is immortal. Why couldn't the designer have made humans immortal? Does he like jellyfish better?
- The human throat. Air and food passages meet and mix, sometimes with fatal results; whales don't have that problem.
- The human blood clotting system. The heir to the Russian throne had hemophilia, which contributed to the Russian Revolution. It is sex-linked, occurring only in males. Does the designer prefer women?
- The human eye requires light to pass through many layers of cells before reaching the photoreceptors. In the cephalopod eye, the light hits the photoreceptor cells first, and they see better and in dimmer light than we do and can recognize polarized light. Does the designer prefer squid and octopuses to humans?
- We can't make our own vitamin C; most animals can. We get scurvy; cats and dogs don't. What's worse, we have the entire pathway to make vitamin C except for the last step. We can't manufacture that one last enzyme.
- We only get two sets of teeth; sharks have replaceable teeth and don't have to go to the dentist.
- Female sharks can reproduce without males; humans can't.
- The human appendix is unnecessary and only causes problems requiring surgery.

This is not intelligent design. The only logical conclusion is that the designer is incompetent or favors other animals above humans, but ID proponents don't seem to recognize that.

There are many other flaws Hafer could have covered, but she opted for economy to leave room for an impassioned defense of science and a full rebuttal of ID. For those who want to know more, Nathan Lents covered many more flaws in his book *Human Errors: A Panorama of Our Glitches, from Pointless Bones to Broken Genes*.

Hafer includes a cogently argued defense of science and evolution and shows how science denial causes harm. She provides a two-part Handy Dandy Intelligent Designer Refuter with answers to every point ID proponents might bring up in an argument. She spends considerable time refuting the "irreducible complexity" argument, explaining how the eye and the flagellum evolved. She ridicules ID promoters for not knowing the difference between a cilium and a flagellum and not knowing that bacteria don't have cilia. The very organism that creationist Michael Behe writes about is a living refutation of his claims about irreducible complexity. It has a system for building a flagellum that is reducible, and he doesn't seem to know about this. It is inexcusable that he didn't do his homework.

Hafer refutes the "academic freedom" argument: "Even college professors do not have the freedom to teach anything they want any way that they want." She notes that she was hired to teach anatomy and physiology, and she would lose her job if she taught Mark Twain instead. His work is fiction, and she is supposed to teach science.

She refutes the "teach the controversy" argument. We don't need to teach the flat-earth "controversy." She comments, "I pity any passenger on an international jet liner whose pilot truly believes that the earth is flat. It could end tragically." Of the creator's flawed design, she asks, "Even Detroit does recalls. Why can't God?"

The Not-So-Intelligent Designer is packed full of information about human anatomy, other animals, and animals that shouldn't exist according to ID. The many illustrations and the snarky sense of humor make it a delight to read. It's less than 200 pages, and the chapters are short and easy to digest. Hafer ends by saying she thinks our bodies are beautiful the way they are, regardless of their imperfections, and there is real beauty in our ability to really understand the world instead of just making things up. She says evolution is "the greatest indisputably true story ever told." She wonders if she is preaching to the choir but says the book's information and arguments are exactly what the choir needs to defend evolution against pseudoscientists and political pressure groups. ID is an anachronism that has no place in the twenty-first century. ■

Harriet Hall, MD, also known as "The SkepDoc," is a retired family physician, a CSI fellow, a Skeptical Inquirer contributing editor, and an editor of the *Science-Based Medicine* blog. Her website is www.skepdoc.info.

The Sunday Sessions and the Heartbreak of Gay Conversion Therapy

Sheldon W. Helms

At the 2017 CSICon conference in Las Vegas, a well known skeptic psychologist asked me what my presentation would be about that weekend. I explained that I was scheduled to talk about the horrors of gay conversion therapy (GCT), and that I advocate for an outright ban of the practice. His response surprised me: "So, you think we should ban a therapy because you don't like it? Shouldn't adults be given the right to seek any therapy they want?" A bit thrown by his summary of the issue, I replied, "I think we should prevent people from furthering the notion that homosexuality is a disease, offering them false hope, and putting them at risk of depression and suicide." He left the conversation noticeably unimpressed by my argument.

The Sunday Sessions. Produced and directed by Richard Yeagley. Dickie Bruce Productions, 2018.

More than a year later, the general public has become much more aware of the problem of GCT. The recent film *Boy Erased*, based on a book of the same name, brought one family's story to light, and numerous articles, podcast episodes, TV shows, and documentaries have further increased public awareness.

In March 2018, another documentary about GCT, *The Sunday Sessions*, was released. This film follows Nathan, a twenty-six-year-old gay man in a small Virginia town, as he avails himself of a variety of religious-oriented counseling services that promise to make him straight.

The film opens with a clip of Chris Doyle, the man who will act as Nathan's therapist, in a 2012 appearance on *The Dr. Oz Show*. Although this may im-

press the uninitiated, many readers will likely raise a skeptical eyebrow to this apparent endorsement by someone known for promoting unscientific ideas. Later, we are privy to scenes from Nathan's everyday life and personal interests, most of which revolve around family, religious activity, and involvement with a local theater group, as well as regular "therapy" sessions with Doyle.

Those in the anti-GCT community will immediately recognize the major players in *The Sunday Sessions*. Early in the documentary we see Nathan in a group therapy run by a face very familiar to me. Although never named, this man is Richard Cohen, a disgraced former psychotherapist who features prominently in my talks. Cohen describes himself as an "ex-gay," as do many pseudo-therapists who offer GCT. He also has the distinction of a lifetime ban from the American Psychological Association (APA) and the American Counseling Association (ACA) for a series of ethical violations. Cohen now runs the International Healing Foundation, a 501(c)(3) nonprofit he founded to provide pseudo-counseling for gays and lesbians in return for a tax-deductible donation. This allows Cohen and his underlings to offer their services without any pesky oversight by the APA or the ACA, both of which have joined over a dozen other professional groups in issuing policy statements denouncing GCT as both ineffective and potentially harmful.

There is no evidence that gay conversion therapy (GCT) practices provide a change in one's sexual orientation, and for a large majority, no lasting change in behavior is seen. What's clear from the research is that this happiness will not be found in GCT. It will bring people only disappointment and failure.

The one-on-one counseling sessions to which Nathan is subjected by Doyle are somewhat predictable yet at times disturbing. Not only does Doyle influence Nathan to cut off communication with the only person who seems willing to support him regardless of his sexual orientation—a gay man named Cameron—but he also repeats Bible verses as inspiration, as well as to support his contention that homosexuality is a disease, a belief not supported by social science. Further, Doyle continually cites discredited Freudian ideas about the "overbearing mother" and the "distant, non-loving father" as reasons for Nathan's attraction to men. Their discussions are riddled with unprofessional (sometimes foul) language, disturbing threats of violence and intimidation, and odd role-playing exercises such as throwing waded up papers at household objects meant to represent family members, as well as a number of other activities that reveal decided bias and unscientific ideas about psychology, psychotherapy, and human sexuality.

Little of what is in these sessions will be in the least familiar to those who provide actual counseling, but this is to be expected. A bit of online sleuthing reveals that Doyle—far from being a renegade therapist who simply seeks to assist those struggling with their sexuality—is actually an employee of Cohen's International Healing Foundation. Doyle's profile on their website even proudly boasts that he is "the first ever recipient of the Dr. Joseph Nicolosi Award for early career excellence." Nicolosi was the founder of the National Association for Research and Therapy of Homosexuality (NARTH) (now cleverly rebranded as the Alliance for Therapeutic Choice and Scientific Integrity), a group that presents itself as a secular ex-gay organization offering GCT but which actually has close ties to many religiously based GCT providers, such as Cohen's. The groups are often quite small and pretend to operate independently, but they tend to have much more interaction, overlap, and collaboration than meets the eye.

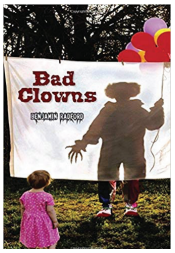
Owing mostly to a decided lack of editorial voice, *The Sunday Sessions* is not the sort of film that seeks to educate viewers on the background of its topic, which may account for its relatively low ratings online. Many Americans have grown accustomed to heavy-handed documentaries that offer shocking revelations or guide them toward a conclusion, none of which is to be found in *The Sunday Sessions*. Moreover, since we are provided with very few details about the protagonist, Nathan, beyond that he is highly religious, active in theater, and a gay man who wants to be straight, the film cannot rightly be called a biography. These facts have even led some to accuse the film of providing a platform for GCT adherents. On the movie's promotional website, however, director Richard Yeagley makes his position clear: "The filming and production of this documentary proved time and time again to be an emotionally taxing process. … No individual in modern times should ever feel the need to hide or change their sexual identity."

Perhaps the most meaningful (and heartbreaking) part of the film is when a frustrated Nathan, choking back tears, tells Doyle, "It seems that other people's happiness comes at a much lower cost than mine." What's clear from the research is that this happiness will not be found in GCT. There is no evidence that GCT practices provide a change in one's sexual orientation, and for a large majority, no lasting change in behavior is seen. GCT will bring people such as Nathan only disappointment and failure. And happiness will only be achieved once people such as Nathan reject the superstition and bigotry that currently inform their beliefs regarding sexual orientation. ■

Sheldon W. Helms is a professor of psychology at Ohlone College in Fremont, California. He writes and speaks extensively about gay conversion therapy and co-chairs the Psychology Forum at the Commonwealth Club of San Francisco. He is the host of the popular science and skepticism podcast *ShelShocked*.

Scrutinizing the 'Bad Clown' Idea

Guy P. Harrison



Bad Clowns. By Benjamin Radford. Albuquerque, NM: University of New Mexico Press. 2016. ISBN 978-0-8263-4666-6. 188 pp. Paperback, $24.95.

Who knew naughty clowns could be so interesting? From mischievous and bizarre to disturbing and dangerous, the wayward jester, it turns out, makes for a fascinating topic of study. With his wildly fun and surprising book *Bad Clowns*, Benjamin Radford wipes away the greasepaint and skillfully illuminates the weird world of clowns gone wrong. He makes it clear up front that he has no animosity toward clowns of any ilk. Radford simply wanted to understand this strange human phenomenon.

The author describes his goal in writing the book was to produce a "mostly serious blend of academic scholarship, pop culture critique, folklore and urban legend research, psychology, and sociological analysis." He succeeded. *Bad Clowns* is a near-perfect collection of all those things and more. Too much emphasis on one or two academic concerns and the book would not likely have been able to hold the great charm and humor that it does. Too little attention to history and psychology, however, and it likely would feel too silly or trite for serious readers. As one who enjoys all history, for example, I appreciated Radford's inclusion of a general survey of world clown history.

Although bad and scary clowns are perhaps more prominent in pop culture today than ever before due to their inclusion in many horror films, Radford reports that there is no clear evidence that fear of, and anxiety about, clowns has risen in recent decades. We can't know this because there is no data from generations past with which to compare. Regardless, it seems to be an extraordinarily small problem in terms of population percentage affected. Radford explains that it barely shows up in medical and psychological research. "Coulrophobia" (fear of clowns), for example, is not even a recognized phobia by psychologists and mental health experts. This is not to say it is not a real and serious problem, only that it is extraordinarily rare.

True to his stature as one of the world's most accomplished and respected skeptical investigators, Radford pays due attention to unfounded hype and hysteria. There are many cases of exaggerations, misinterpretations, and outright lies fueling irrational fears and controversies. Radford explains them away with expert precision. An important point Radford makes, and deserves repeating here, is that depraved or criminal clowns are the exception, not the rule. As he writes, one is more likely to win the lottery than encounter a truly evil clown. But this book is not dedicated solely to exposing myths and frauds. There really have been genuinely bad people who dressed up as clowns. Some of it is entertaining—Bozo has a bad day; Ronald McDonald sparks social protests—and some of it is deeply disturbing.

John Wayne Gacy, the infamous serial killer who sometimes performed as a clown at children's birthday parties, is often held up as Exhibit A in the case against bad clowns. Gacy was convicted and later executed for killing more than thirty people, twenty-eight of whom he buried or hid on his property. To this day, many articles and documentaries about him suggest that he was the ultimate "killer clown." But was he? Radford keenly identifies a problem with this portrayal: Gacy was never a professional clown. He was a building contractor who only occasionally did clown gigs. He is not known to have killed or abducted anyone while wearing a clown suit and makeup. The clown angle, Radford concludes, was irrelevant to his serial killer activities. But the news media continues to find the jarring contrast of brutal killer and birthday party clown irresistible.

Radford presents another glaring case of misleading journalism fueling the bad clown concept. It came out of news coverage of the mass shooting at a theater in Aurora, Colorado, in 2012. The killer, James Holmes, was reported to have been inspired by the Joker (Batman's archenemy and perhaps the most famous bad clown in all of fiction). Radford reveals, however, that this was yet another "media-created myth." There was no mention of the Joker during Holmes's trial, and nothing about the Joker emerged from the intense and extensive investigation into his past and motivations for the crime. Even Holmes's own notebook, containing written plans for the attack, did not include any mention of the Joker.

Lest you think yourself safe, Radford offers a surprise word of caution for all of us: Bad clowns may be on the rise. He connects troublesome clowns of decades and centuries past with contemporary online trolls: malevolent people who seek enjoyment or thrill through annoying, tormenting, and scaring people in cyberspace may be the new nasty jesters of our time. You have been warned.

There is so much in *Bad Clowns* that everyone, from casual clown fans to hardcore skeptics and academics, will find plenty to both entertain and enlighten. ■

Guy P. Harrison is the author of eight books that promote science and reason and is a commentary writer for *Psychology Today*. His latest book is *At Least Know This: Essential Science to Enhance Your Life*.

Cold Fusion Thirty Years Later

Reading the article "Cold Fusion: Thirty Years Later" (January/February 2019) reminded me of some interesting discussions that occurred at the time.

In 1989, when Pons and Fleischmann made their announcement concerning "cold fusion," the internet was still fairly new, but it did exist, and there were some early versions of what would evolve into "social media," in the form of online fora distributed by services such as "USENET news." There were hundreds of groups with common interests of all sorts, but the important ones in this instance were "sci.chemistry" and "sci.physics." Being a technical sort, I was subscribed to both.

In the chemistry forum, the participants were discussing possible chemical reactions and their proposed efficiency, which ones were most likely in the experimental environment described in the announcement, what the reaction products would be, how much temperature rise would be expected, and so forth.

Meanwhile, over in the physics forum, the common question was "Why aren't they dead?"—from radiation poisoning, which there would have been a lot of had the experiment actually worked.

Isaac Wingfield
Petaluma, California

The E-Cat Hoax

In "Why E-Cat Is a Hoax" (January/February 2019), I was surprised to find that author Sadri Hassani lays blame for scientific illiteracy in general, and belief in cold fusion in particular, on John Wheeler. Since John is no longer around to defend himself against this nonsense, I'll do my best—leaving the defense of Bohr, Heisenberg, Pauli, and Schrodinger, tarred with the same brush, to others.

Wheeler, by his own admission, was obsessed with the question "Why the quantum?" The Copenhagen Interpretation, which delivers all of quantum mechanics' unchallenged powers of computation and prediction, still leaves us without understanding of its underlying mechanisms (if any). Wheeler took this most-successful theory and interpretation at face value and spent the latter part of his career trying to crack open what it meant. There may be some poetry in this, but it is not mysticism. Blaming him for Deepak Chopra is just silly.

It is certainly disappointing to find John Wheeler disparaged in Skeptical Inquirer. Because of his association with the stranger aspects of general relativity (e.g., black holes) and quantum mechanics (e.g., delayed choice), he attracted more than his share of crackpots, and his methods for dealing with them are legendary. He is also famous for his attempt to rid the AAAS of its affiliation with parapsychology. He should be a hero to your readers.

Peter D. Meyers
Princeton, New Jersey

I enjoyed Sadri Hassani's article on the E-Cat Hoax. I sympathize with his critique of scientists who have contributed to common misunderstandings of modern physics (and especially quantum mechanics) in their popular books by using colorful and easily misunderstood language such as "quantum teleportation," which of course is not at all the same as the science fiction idea of teleportation.

However, his criticism of the philosophy of John Archibald Wheeler or the founders of quantum mechanics massively overstates the problem and comes close to a prohibition of philosophical discussions. Of course, many great scientists have flirted with strange philosophies, but this in no way implies "they believe in ideas that contradict their science," as Hassani claims without going into details. In any case, it should not be forgotten that revolutionary scientific ideas often originated in the philosophical leanings of their proponents.

His article takes a further turn into bizarre territory when he claims—without any supporting evidence—that the public is "more prone to scientific conspiracy theory than its political counterpart" when in fact many scientific conspiracy theories are motivated by political ideology (Stephan Lewandowsky, et al., "The Role of Conspiracist Ideation and Worldviews in Predicting Rejection of Science," *PLOS One* 8(10), 2013). If Hassani has an axe to grind with some forms of science communication, the readers of Skeptical Inquirer might be better served by a more detailed critique in a separate article.

Dr. Philippe Leick
Gerlingen, Germany

I spent the better part of a year chasing down the facts (almost nonexistent) and the falsehoods (predominantly) surrounding the convicted fraudster Andrea Rossi. I am pleased to see that one of your writers has found the investigative work I did to expose this scam.

Steven B. Krivit
Publisher and Senior Editor,
New Energy Times
San Rafael, California

Sadri Hassani replies:

Peter Meyers and Phillipe Leick (and a few other readers) lament my criticism of John Wheeler, and as one of his admirers who benefited from his mentorship as a first-year graduate student at Princeton University many years ago, I struggled with the decision to criticize him. However, in writing my article, my responsibility of exposing the nonsense of modern gurus who exploit his extra-scientific views outweighed my reverence to Wheeler.

In his genuine obsession with "Why the quantum?," Wheeler is indeed to be commended. However, in his sometime far-fetched conclusions, he provides powerful ammunition for modern gurus, New Age mystics, and pseudoscientists. And in so doing, he is following a tradition that has afflicted quantum physics from the very beginning. Self-help books are filled with references to the founders of quantum theory who, regrettably, had an inclination toward mysticism.

When great physicists make mystical utterances, we cannot blame self-help fraudsters for exploiting them. If we could split John Wheeler into a "black hole Wheeler" and the Wheeler who said, "you create the universe" and the "universe is adapted to man," then I would join Peter Meyers in recommending the former as the hero of SI readers. Otherwise, we would be playing into the hands of self-help charlatans. If we don't separate physicists from their physics, we put our stamp of approval on the nonsense propagated by the mystics that is poisoning the minds of hundreds of millions of people. I'll end my response to the letters with the same sentence with which I ended my article: It is the message that counts, not the messenger.

Sputtering Creator Belief

In 1966, John Lennon said, "Christianity will go. It will vanish and shrink. I needn't argue about that; I'm right and will be proved right." This sounds very much like the argument SI constantly makes in one form or another—Gregory Paul being the latest example ("The Sputtering Engine of Creator Belief," January/February 2019).

Unfortunately, for all my skeptical friends, this is not happening! As Tim Keller writes in *Making Sense of God*, "Most sociologists now agree that the secularization thesis—that religion declines as a society becomes more modern—has been empirically shown to be false." Far from sputtering, the engine of belief continues to hum along just fine and even seems to be increasing in horsepower!

As a believer in God *and* a reader of the Skeptical Inquirer, I would ask for two things. First, I'd ask for an admission that faith and science are not mutually exclusive. One can believe in God as creator

and still believe that God accomplished creation using the wonders of science. Second, I would ask for a bit more humility in claiming the realm of reason as being the exclusive domain of atheism and agnosticism. After all, beyond various claims regarding the source of morals and meaning, which really makes more sense: an uncaused god, or an uncaused cause? In the end, neither can be proved or disproved … which just might make *both* articles of faith!

David Garrard
Finchville, Kentucky

Gregory Paul replies:

Among those who disagree with Garrard's claim that Christianity is not shrinking are the authors of the World Christian Encyclopedia *who bemoan that "massive defections from Christianity … took place in Western Europe due to secularism … and in the Americas due to materialism."*

Garrard makes the common narcissistic theist demand that skeptics agree that faith is compatible with science while severely criticizing other unsubstantiated belief systems. But why? One important reason many do not is because those of faith often appear to have problems dealing with facts. In my article, I presented one statistic after another detailing how religion is in overall decline. RedC and the World Values Survey have measured a shrinkage of theism of over a tenth of the global population since the turn of the century. Ignoring the credible data, Garrard's citing a pastor's book claiming the contrary is like citing a creationist's book claiming to have refuted Darwin.

When it comes to skepticism, I am not a bigot; I'm an equal-opportunity skeptic. I have yet to hear a viable argument as to why believing in a supernatural creator is any more plausible than is, say, the belief that aliens had something to do with the creation of humans or of the pyramids. Why is being a god believer in any way superior to thinking Bigfoot is real, as some atheists I know ardently do? Although at least we know that big apes and protohumans are real; the deity thing is worse because it is sheer speculation.

Especially and totally bogus is the conceit that a creator deity can in any way be a source of morality or even common decency. As I detailed in a 2009 paper in Theology and Philosophy, *if there is a creator of our brutal planet, it has overseen the death of fifty billion children, most due to the diseases the supposedly loving god allowed our planet to be infested with. It is abjectly impossible for a creator that gives a damn about the lives of children and human free will to exist.*

There is no need for skeptics to be faith friendly. Instead, it is theists who need to finally admit there is no such thing as a good god.

Gregory S. Paul's article seems to me to be asking the wrong question. If we accept that a decreasing percentage of the human race now espouses traditional religious beliefs, the right question is whether the beliefs being adopted are any more rational. For instance, in the previous century, masses of people abandoned messianic theistic religion for messianic atheistic Communism. Old wine in new bottles still makes people drunk. I would prefer to know whether people are getting more rational rather than whether they are simply changing superstitions.

Nina G. Wouk
Menlo Park, California

Cancer Screening

Felipe Nogueira makes a sensible point by suggesting that certain prostate and breast neoplasms be renamed to indicate their indolent course ("Screening for Prostate and Breast Cancer," January/February 2019). This has been done in other organs, notably urinary bladder and thyroid. While urologists have criteria that allow them to assign some prostate cancer patients to active surveillance, thus avoiding or delaying treatment, there are currently no histologic criteria that pathologists can use to reassign certain prostate and breast cancers to other categories. That will take a significant amount of time and research.

I look forward to the day when we can more accurately classify these neoplasms and allow those patients who do not need to be treated to avoid the consequences of chemotherapy, surgery, and radiation.

Michael Finfer, MD
Assistant Chairman
Department of Pathology
JFK Medical Center
Edison, New Jersey

Felipe Nogueira's discussion of prostate cancer screening and PSA testing was comprehensive and well referenced. However, it failed to mention a more recent development in prostate cancer screening, magnetic resonance imaging (MRI). This technology is playing an increasing role in assessing patients with early prostate cancer, including those with abnormal PSA levels prior to definitive interventions. MRI-based assessment has been shown to better distinguish between clinically significant and insignificant tumors than PSA testing alone. Preliminary data indicate that MRI can outperform PSA in the identification of patients with clinically significant prostate cancer.

The advent of multiparametric prostate MRI allows clinicians to now see cancers that are significant and life-threatening while at the same time avoiding the diagnosis of the insignificant ones and overtreatment. However, MRI utilization requires new expertise for the urologists who perform prostate biopsy as part of prostate cancer treatment decisions.

Tim Skene
Montreal, Quebec

MPD, Life, and the Universe

The Research Review "Could Multiple Personality Disorder Explain Life, the Universe, and Everything?" by Robert Stern (January/February 2019) tarnishes the image of this magazine and skepticism.

While attempting to criticize an essay of the same title by me and others on scientificamerican.com, Stern admittedly fails to understand the essay or even discern what it does and doesn't claim. For instance, he states—embarrassingly—that we illegitimately bring quantum physics into our argument, while the word *quantum* doesn't even appear in our essay. He criticizes one of the papers we cite as being based on subjective claims, while somehow missing the point that the paper's thrust is precisely the use of objective EEG measurements.

Most embarrassingly of all, Stern believes our central claim to be that *having* multiple personality disorder helps one understand life and the universe, and then dedicates most of his article to countering this straw man. It's hard to see how any minimally attentive reader, who read beyond the title, could misinterpret our essay so pitifully. Our claim, of course, is that the observable psychological dynamics underlying a dissociative disorder can help a philosopher who *studies* the disorder tackle the so-called "decomposition problem" in philosophy of mind. The philosopher does not need to *have* the disorder himself to attain this insight.

Beyond a failure of skepticism, Stern's article betrays an embarrassing lack of basic understanding of the issues addressed. Your magazine deserves better.

Bernardo Kastrup
Eindhoven, The Netherlands

Robert Stern replies:

It is true that I fail to understand Mr. Kastrup's essay, but it is not for want of trying. Let me take his criticisms in order:

1. While the word quantum *does not appear anywhere in his article, the tenth paragraph begins "Physical entities such as subatomic particles possess abstract relational properties, such as mass, spin, momentum, and charge." Those are precisely the subjects of quantum physics, although I'm puzzled by the subsequent suggestions that "matter already has experience from the get-go," and that "even subatomic particles possess some very simple form of consciousness." Evidence, please?*

2. The MPD patient with sighted and blind "alters" did not have an EEG; she had a Visually Evoked Potential (VEP) exam, testing the integrity of her visual system.

The two exams are not the same. Dr. Strasburger, who performed the VEP, arrived at what appears to be an obvious diagnosis: psychogenic blindness.

3. VEPs are not objective, only suggestive. I can point Mr. Kastrup to several ophthalmology journal articles reporting the ease of dissimulating blindness during VEP exams by misdirecting attention, "front-focusing," and even meditating. An EEG would have lessened those possibilities.

4. Psychological dynamics are not observable.

5. I can offer no defense for misinterpreting the article's theme as having anything to do with MPD/dissociation other than to point out that with the title, the subheading, and eleven of the seventeen paragraphs discussing or referring directly to MPD/dissociation, it's hard to conclude otherwise.

The IPCC Report

Amardeo Sarma's dismissal of the IPCC's reduced energy use scenarios (News and Comment, January/February 2019) appears to be based on two false assumptions: 1) Correlation is causal; and 2) a reduction in overall energy use implies a reduction in the energy use of developing countries.

People use energy for the services that it provides. It is the services, such as refrigeration or lighting, and not the energy use per se that drives development and provides for human welfare. Efficiency has improved dramatically for some end uses, and over 45 percent of the countries with a GDP (PPP) greater than the average had a declining energy use since 2006 (BP statistical review). This is despite the fact that the population increased in 70 percent of these countries. As population growth increasingly slows and technology spreads, more countries will be able to reduce energy use.

In 2017, the population of countries with above-average GDP (PPP) was only 25 percent of the world population, but their energy use was 58 percent of the total. A 1 percent drop in their energy use would balance a 1.4 percent increase elsewhere. This is not an easy goal, but it is probably more realistic than assuming that the people of the world have the will, money, expertise, and time to stave off global warming by building nuclear power plants.

Robert Clear
Berkeley, California

Amardeo Sarma replies:

Robert Clear is correct to point out that there is a huge potential in energy saving measures in high-income countries. Such savings are not going to be easy and will take decades. At the same time, there is no way a world population of ten billion is going to be able to use less energy than today. Realistically, even with energy savings, we would be looking at almost doubling today's primary energy production.

Even if we were to maintain current levels of energy production globally, we would need to decarbonize our energy systems using all low-carbon energy sources available. It is not an option to use CO_2-emitting fossil fuels such as natural gas as a backup. We do not have the luxury to leave out proven low-carbon options such as nuclear to come to net emissions that are close to zero within one or two decades.

Those Martian Canals Again

Please allow me to send a short comment regarding a previous letter published in Skeptical Inquirer, the letter "Those Illusory Canals" by Klaus R. Brasch (November/December 2018).

In the last paragraph, it says that "finally, it must be pointed out that not all the martian 'canals' were illusory, just not artificial." The letter then makes reference to Valles Marineris, the giant canyon (or canal in the broad sense of that term) located near Mars's equator.

However, it should be pointed out that if it was "observed" by Percival Lowell (or anybody else at the time) that finding would have been purely serendipitous because that feature is invisible to telescopes available at the time. Valles Marineris (the best case) was discovered in 1972 by the Mariner 9 spacecraft.

Manfred Cuntz
Department of Physics
University of Texas at Arlington

Klaus Brasch replies:

In his comments on my letter "Those Illusory Canals," Manfred Cuntz states that it would have been impossible or purely serendipitous for Percival Lowell and others to see the giant Martian canyon, Valles Marineris, with any telescope available at the time. I must respectfully disagree. None other than noted planetary scientist William K. Hartmann makes the following statement in his book A Traveler's Guide to Mars *(Workman Publishing, 2003): "Proof that some of Schiaparelli's and Lowell's much-criticized canals were based on real features can be found in a Martian region known as Xanthe."*

During favorable Martian oppositions, Valles Marineris can indeed be spotted in this region, even with larger amateur telescopes, as a dark albedo feature called Coprates in the pre-Mariner spacecraft days, lying just north of Solis Lacus (sometimes referred to as The Eye of Mars). It was also repeatedly photographed by astronomer Earl C. Slipher with the Lowell twenty-four-inch Clark refractor (see Mars: the Photographic Story, *Sky Publishing Corp., 1962). Schiaparelli, using an 8.6-inch refractor at Brera Observatory in Milan, first noted and named this feature Agathodeamon in 1888. In 1909, using a much larger 32.6-inch refractor at Paris Observatory, legendary planetary observer E.M. Antoniadi also saw it but depicted it not as a typical "canal" but as a mottled, wider feature.*

Part of the popular confusion about Lowell's imaginary artificial canals is that he depicted them as very thin, linear features that, if real, were well beyond the resolving power of any Earth-based telescope. He and many others, however, also saw extended streaks and contrast features, probably due to wind-blown dust but also some larger Martian structures such as Valles Marineris.

Apology to James Alcock

I owe James Alcock an apology and a brief clarification. In my fervor to discredit organized religion (Letters, November/December 2018), I inadvertently misunderstood his stated premise (in his article "The God Engine," September/October 2018). Supernatural belief is a natural consequence of normal cognitive development. Children at an early age, who are not concerned with mortality, do imagine—and believe—the existence of many things: the tooth fairy, gnomes, trolls, leprechauns, imaginary playmates, the Thing lurking in the closet, etc., etc., all supernatural beings. I just don't connect this indisputable fact to the (to me) also indisputable fact that adult humans, unable to understand the mystery of death, have imagined and constructed a false narrative. I certainly do not believe that fear of death is the reason that humans believe in the supernatural, and I did not mean to imply that. Alcock is without question correct. I suppose it was the title of the article that got me started. When the subject of God and the baggage that accompanies it is raised, I bristle, and sometimes it causes my language to sound critical and combative, and I apologize for that too.

Gene White
Santa Fe, New Mexico

[FEEDBACK

The letters column is a forum on matters raised in previous issues. **Letters should be no longer than 225 words**. Due to the volume of letters we receive, not all can be published. Send letters as email text (not attachments) to letters@csicop.org. In the subject line, provide your surname and informative identification, e.g.: "Smith Letter on Jones evolution article." Include your name and address at the end of the letter. You may also mail your letter to the editor to 944 Deer Dr. NE, Albuquerque, NM 87122.

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Council Against Health Fraud, Atlanta, GA

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computer scientist/executive (Bell
Labs, then Silicon Valley), analyst of
climate-change denial, contributor to
DeSmogBlog and Skeptical Science, Portola
Valley, CA

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astrophysicist, Pasadena, CA

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astronomer, USAF pilot (ret.)

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David Willey,
physics instructor, Univ. of Pittsburgh, PA

Affiliated Organizations | United States

ALABAMA
Alabama Skeptics, Alabama. Emory Kimbrough. Tel.: 205-759-2624. 3550 Watermelon Road, Apt. 28A, Northport, AL 35476

ARIZONA
Tucson Skeptics Inc. Tucson, AZ. James McGaha. Email:mcgaha@skepticus.com. 5100 N. Sabino Foothills Dr., Tucson, AZ 85715

Phoenix Area Skeptics Society (PASS) http://phoenixskeptics.org
Email: phoenixskeptics@gmail.com

Phoenix Skeptics, Phoenix, AZ. Michael Stackpole, P.O. Box 60333, Phoenix, AZ 85082

CALIFORNIA
Sacramento Organization for Rational Thinking (SORT) Sacramento, CA. Ray Spangenburg, co-founder. Tel.: 916-978-0321; Email: kitray2@comcast.net. PO Box 2215, Carmichael, CA 95609-2215 http://home.comcast.net/~kitray2/site/

Bay Area Skeptics (BAS) San Francisco–Bay Area. Eugenie C. Scott, President. 1218 Miluia St., Berkeley, CA 94709. Email: scott@ncse.com. www.BASkeptics.org

Independent Investigations Group (IIG), Center for Inquiry–Los Angeles, 4773 Hollywood Blvd, Los Angeles, CA 90027. Tel.: 323-666-9797. www.iighq.com

Sacramento Skeptics Society, Sacramento. Terry Sandbek, President. 4300 Auburn Blvd. Suite 206, Sacramento CA 95841. Tel.: 916 489-1774. Email: terry@sandbek.com

San Diego Association for Rational Inquiry (SDARI) President: Tom Pickett. Email: pickett.thomasj@gmail.com. Program/general information 619-421-5844. www.sdari.org. Postal address: PO Box 623, La Jolla, CA 92038-0623

CONNECTICUT
New England Skeptical Society (NESS) New England. Steven Novella M.D., President. Tel.: 203-281-6277; Email: board@theness.com. 64 Cobblestone Dr., Hamden, CT 06518 www.theness.com

D.C./MARYLAND
National Capital Area Skeptics NCAS, Maryland, D.C., Virginia. D.W. "Chip" Denman. Tel.: (240) 670-6227. Email: ncas@ncas.org. PO Box 8461, Silver Spring, MD 20907-8428 http://www.ncas.org

FLORIDA
Tampa Bay Skeptics (TBS) Tampa Bay, Florida. Rick O'Keefe, contact person. Tel.: 813-505-7013; Email: tbs@centerforinquiry.net. c/o O'Keefe, 4011 S. Manhattan Ave. #139, Tampa, FL 33611-1277. www.tampabayskeptics.org

ILLINOIS
National Examination Association of Lincoln Land (REALL) Illinois. Bob Ladendorf, Chairman. Tel.: 217-546-3475; Email: chairman@reall.org. PO Box 20302, Springfield, IL 62708 www.reall.org

Chicago Skeptics Jennifer Newport, contact person. Email: chicagoskeptics@gmail.com. www.chicagoskeptics.com

LOUISIANA
Baton Rouge Proponents of Rational Inquiry and Scientific Methods (BR-PRISM) Louisiana. Marge Schroth. Tel.: 225-766-4747. 425 Carriage Way, Baton Rouge, LA 70808

MICHIGAN
Great Lakes Skeptics (GLS) SE Michigan. Lorna J. Simmons, Contact person. Tel.: 734-525-5731; Email: Skeptic31@aol.com. 31710 Cowan Road, Apt. 103, Westland, MI 48185-2366

Tri-Cities Skeptics, Michigan. Dr. Gary Peterson. Tel.: 989-964-4491; e-mail: peterson@svsu.edu. www.tcskeptics.blogspot.com

MINNESOTA
St. Kloud Extraordinary Claim Psychic Teaching Investigating Community (SKEPTIC) St. Cloud, Minnesota. Jerry Mertens. Tel.: 320-255-2138; Email: gmertens@stcloudstate.edu. Jerry Mertens, Psychology Department, 720 4th Ave. S, St. Cloud State Univ., St. Cloud, MN 56301

MISSOURI
Skeptical Society of St. Louis (SSSL) St. Louis, Missouri. Michael Blanford, President. Email: info@skepticalstl.org. 2729 Ann Ave., St. Louis, MO 63104 www.skepticalstl.org

St. Joseph Skeptics
P.O. Box 8908
St. Joseph MO, 64508-8908

NEVADA
Reno Skeptical Society, Inc.,
Brad Lutts, President.
Tel.: (775) 335-5505;
Email: info@RenoSkeptics.org. 18124 Wedge Parkway #1052 Reno, Nevada 89511. www.RenoSkeptics.org

NEW MEXICO
New Mexicans for Science and Reason (NMSR) New Mexico. David E. Thomas, President. Tel.: 505-869-9250; Email: nmsrdave@swcp.com. 801 Fitch Ave., Socorro, NM 87801. www.nmsr.org

NEW YORK
New York City Skeptics Michael Feldman, president. PO Box 5122 New York, NY 10185. www.nycskeptics.org

Central New York Skeptics (CNY Skeptics) Syracuse. Lisa Goodlin, President. Tel: (315) 636-6533; Email: info@cnyskeptics.org, cnyskeptics.org PO Box 417, Fayettville, NY 13066

OHIO
Central Ohioans for Rational Inquiry (CORI) Central Ohio. Charlie Hazlett, President. Tel.: 614-878-2742; Email: charlie@hazlett.net. PO Box 282069, Columbus, OH 43228

Cleveland Skeptics Joshua Hunt, Co-Organizer, www.clevelandskeptics.org

South Shore Skeptics (SSS) Cleveland and counties. Jim Kutz. Tel.: 440 942-5543; Email: jimkutz@earthlink.net. PO Box 5083, Cleveland, OH 44101 www.southshoreskeptics.org

Association for Rational Thought (ART) Cincinnati. Roy Auerbach, president. Tel: (513)-731-2774, Email: raa@cinci.rr.com. PO Box 12896, Cincinnati, OH 45212. www.cincinnati skeptics.org

OREGON
Oregonians for Science and Reason (04SR) Oregon. Jeanine DeNoma, president. Tel.: (541) 745-5026; Email: wilkinsa@peak.org; 39105 Military Rd., Monmouth, OR 97361. www.04SR.org

PENNSYLVANIA
Philadelphia Association for Critical Thinking (PhACT), Bob Glickman President. 653 Garden Road Glenside PA 19038. 215-885-2089 E-mail: President@phact.org. Website: www.phact.org

TENNESSEE
Rationalists of East Tennessee, East Tennessee. Carl Ledenbecker. Tel.: (865)-982-8687; Email: Aletall@aol.com. 2123 Stonybrook Rd., Louisville, TN 37777

TEXAS
North Texas Skeptics NTS Dallas/Ft Worth area, John Blanton, Secretary. Tel.: (972)-306-3187; Email: skeptic@ntskeptics.org. PO Box 111794, Carrollton, TX 75011-1794. www.ntskeptics.org

VIRGINIA
The James Randi Educational Foundation. James Randi, Director. 2941 Fairview Park Drive, Suite 105 Falls Church, VA 22042
Email: jref@randi.org
Telephone: 571-318-6530

Science & Reason, Hampton Rds., Virginia. Lawrence Weinstein, Old Dominion Univ.-Physics Dept., Norfolk, VA 23529

WASHINGTON
Seattle Skeptics
www.seattleskeptics.com

The organizations listed above have aims similar to those of the Committee for Skeptical Inquiry but are independent and autonomous. Representatives of these organizations cannot speak on behalf of CSI. Please send updates to Barry Karr, P.O. Box 703, Amherst NY 14226-0703.
International affiliated organizations listed at www.skepticalinquirer.org.

CENTERS FOR INQUIRY
www.centerforinquiry.net/about/branches

Transnational
3965 Rensch Road, Amherst, NY 14228
Tel.: (716) 636-4869

Austin
PO Box 300036, Austin, TX 78703
Tel.: (512) 454-0977

Chicago
chicago@centerforinquiry.org

Indianapolis
350 Canal Walk, Suite A, Indianapolis, IN 46202
Tel.: (317) 423-0710

Los Angeles
2535 W. Temple St., Los Angeles, CA 90026
Tel.: (323) 666-9797

Michigan
3777 44th Street SE, Grand Rapids, MI 49512
Tel.: (616) 698-2342

New York City
33-29 28th St. Astoria, NY 11106

San Francisco
email: sf@centerforinquiry.org

Tampa Bay
4011 S. Manhattan Ave. #139, Tampa, FL 33611-1277
Tel.: (813) 505-7013

Washington, DC
1020 19th Street NW, Suite 425
Washington, DC 20036
tel.: (202) 629-2403

Argentina
Buenos Aires, Argentina
alejandroborgo@gmail.com
Facebook: CFI Argentina

Canada
55 Eglinton Ave. East, Suite 307
Toronto, Ontario, M4P 1G8, Canada

China
China Research Institute for Science Popularization,
NO. 86, Xueyuan Nanlu Haidian Dist., Beijing,
100081 China
Tel.: +86-10-62170515

Egypt
44 Gol Gamal St., Agouza, Giza, Egypt

France
Dr. Henri Broch, Universite of Nice, Faculte des Sciences, Parc Valrose, 06108, Nice cedex 2, France Tel.: +33-492-07-63-12

Germany
Arheilger Weg 11, 64380 Rossdorf, Germany
Tel.: +49-6154-695023

India
46 Masi garh, New Friends Colony
New Delhi 110025
Tel.: 91-9868010950

London
Conway Hall, 25 Red Lion Square,
London WC1R 4RL, England

Nepal
Humanist Association of Nepal,
PO Box 5284, Kathmandu Nepal
Tel.: +977-1-4413-345

New Zealand
email: bcooke@centerforinquiry.net

Nigeria
PO Box 25269, Mapo, Ibadan, Oyo State, Nigeria
Tel.: +234-2-2313699

Peru
Ex. Dir. Manuel Paz-y-Miño
Calle El Corregidor 318, Rimac, Lima 25-PERU
email: humanarazon_peru@yahoo.com

Poland
Lokal Biurowy No. 8, 8 Sapiezynska Sr.,
00-215, Warsaw, Poland

Romania
Fundatia Centrul pentru Constiinta Critica
Tel.: (40)-(0)744-67-67-94
email: CenterforInquiry.Romania@gmail.com

Russia
Dr. Valerii A. Kuvakin, 119899 Russia, Moscow,
Vorobevy Gory, Moscow State Univ.,
Philosophy Department

Senegal
PO Box 15376, Dakar – Fann, Senegal
Tel.: +221-501-13-00

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